Revolutionary Theories In Wireless

By

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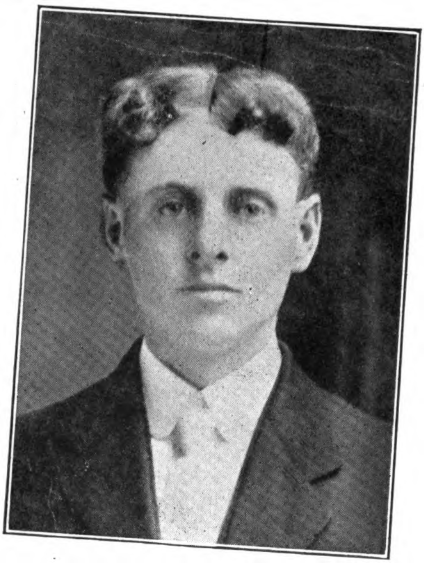

Frank E. Summers

AUTHOR'S NOTE

I have studied and experimented with electricity for about 18 years. It was about 15 years ago when I first purchased and studied a wireless book. I studied it very closely and I was convinced then that the theories therein were wrong. In my mind flashed ideas which should work according to my theories and many of them are in use today. This was years before they were thought of by scientists. But many of my ideas and theories have never been published yet. It is the aim of this book to publish some of my theories and inventions which I believe will be interesting to all concerned in the science of Electricity in its different branches.

This book, which advances theories and inventions which are revolutionary in character, does not apply to wireless alone, but to many other branches of electricity. Such as light, X-rays, violet rays, cathode rays, lightning, radium, static, heat rays and many other branches of science.

After years of careful study and experimenting I have become more convinced that the theories in this book applying to wireless are according to the electrical laws of Nature, which I believe the future will prove. If only one of the theories advanced in this book proves to be right in the future, then I will consider my time well spent. But if a majority of the theories herein prove to be right then wireless, static, light, X-rays, and other branches of science will be greatly simplified. Also then the theories herein will open up new fields of experimentation to which there will be no end.

Electricity is beyond doubt God's greatest gift to humanity. No doubt but that all of our senses are based upon electricity in some way or other. Light in all its forms is beyond doubt electricity. In electricity are possibilities little thought of at present. In it are great opportunities for the student and experimenter. No doubt through electricity will be solved many of the perplexing problems of today such as perpetual motion, means to prevent and eradicate disease, means to assist in curing the blind, wireless light, visible X-rays and many other things that have never even been thought of.

If science had adopted Prof. Hughs theories of wireless as being invisible electric waves traveling by conduction through the air, as he proposed long before the theory of induction proposed by Hertz, no doubt wireless telephone would have been as common as line telephones are today and visible wireless waves would probably be used now for lighting cities. Visible X-rays would have been here long before this. With visible X-rays no flourescence screen would be needed, as the X-ray shadow would show up against any dark background.

In this book I will show how all this may come to pass in the future when we have more efficient means to control the wave length. Also when we have more efficient means to send out wireless currents of very short wave lengths.

I am inclined to believe that wireless is simple; there are not any mysteries that cannot be explained according to the electrical laws of nature.

This book describes in a very brief way my theories, and some of the proofs that seem to bear them out. I will publish a much larger and more complete book later giving more proof of my theories and some interesting inventions. On account of lack of means and insufficient patent protection I will not put them in this book. But I will publish enough to prove very interesting I think to all concerned in the art. I trust that the theories herein will help to advance and simplify the wireless art. In writing this book I have referred mainly to such books as "First Steps in Electricity" by Harrison, "Electricity and Magnetism" by Sylvanus P. Thompson, "Practical Wireless Telegraphy" by Elmer E. Bucher, and other similar elementary books which should be in the library of every electrical student. For a more complete treatise than I have written in this book on static, magnetism and the principles of electricity I refer the reader to such books as above.

FRANK E. SUMMERS,

November 1919. Memphis, Mo.

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CHAPTER I.

Revolutionary Theories In Wireless

——By——

FRANK E. SUMMERS

Electricity and Magnetism

1—Electricity. For a person to understand wireless he must become familiar with all the various branches of electricity, such as static electricity at rest and in motion, electro and electro-static attraction, repulsion and induction, magnetism and electro-magnetism, voltaic currents, electro-static stress and similar phenomena. In a brief way I will try to explain the most necessary branches of electricity that apply to the wireless art. Nobody knows at present what electricity is, but we can use it, we can change it from one place to another, but we cannot make it. Electricity is one of the mysteries of science and no doubt some one in the future will find out what it is. We see it in use every day, in the electric light, automobile, airplane, electric railway, telephone, X-ray, wireless, line telegraphy and in many other ways. These are used at present for the welfare of humanity and to annihilate distance. The day is not far distant when we can talk by wireless telephone with people in a foreign country as easy as we can talk with people in our own state. Means also will be found whereby foreign countries can talk with one another by submarine cable. The day is not far off when a trip can be made from New York to London in 10 hours by a flying machine. Electricity will bring all this to pass and many

more things little thought of today. It is impossible for me to follow the progress of electricity from its first conception about 600 B. C. to the present time, in the limited space of this book, only in a very brief way. I will dwell briefly upon the main branches of electricity that apply to the wireless art, so that my theories may be more easily understood and explained.

2.—Magnetism. Magnetism was discovered by the Ancients in Magnesia, Asia Minor, in the form of metal oxide of iron, and is termed loadstone. This iron has magnetic properties in its natural state and was probably caused originally by earth currents. It has power to attract other paramagnetic bodies. But later it was discovered that other metals could be made

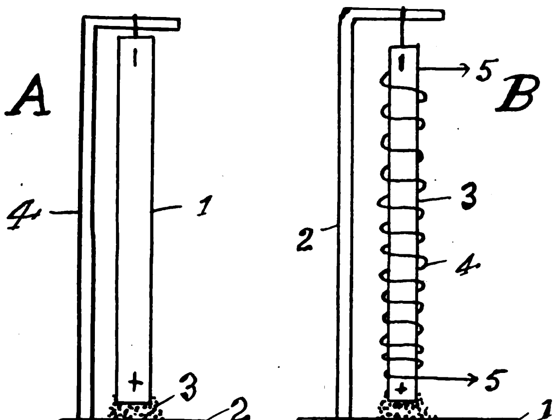

Fig. 1 Magnetic and electro-magnetic attraction

magnetic when loadstone was held against or near other paramagnetic metals. It was also found that if a loadstone magnet be rubbed against a piece of steel, it becomes a permanent magnet. But if soft iron is treated in like manner it loses its magnetism as soon as the loadstone magnet is removed. Some elements and

metals are feebly repelled from magnets. Elements that are repelled are termed diamagnetic and those that are attracted, paramagnetic. The principles of magnetism are better explained by Fig. 1A, showing a base 2, upon which is mounted a support 4. A permanent or loadstone magnet is held in a vertical position by said support, and in attractive relation to the paramagnetic filings 3. It takes a strong magnet to attract the filings one inch. Below is a table showing mainly those elements that are paramagnetic and diamagnetic.

Paramagnetic	Diamagnetic
Iron	Bismuth
Nickel	Phosphorus
Cobalt	Antimony
Manganese	Zinc
Chromium	Mercury
Cerium	Lead
	Silver
	Copper
	Gold
	Water
	Alcohol

Above elements are arranged in their order of strength, as to their paramagnetic or diamagnetic power.

3—Electro-Magnetism. It has also been discovered that when a current of electricity travels through a wire, a magnetic field exists at right angles to the wire. If an insulated wire be wound around a soft iron core, and an electric current sent through the coils the core becomes an electro-magnet as long as the current flows. If steel be used for the core then the steel never loses all of its magnetism. If the core be built up of a bundle of soft wires the strength of the electro-magnetic field is increased. This is better known as laminated cores. The action of electro-

magnetism is better explained by Fig. 1B, showing a base 1 upon which is mounted a support 2, which holds in a vertical position the paramagnetic core 3. Around the core is wound many turns of insulated wire. The end of the core being in attractive relation to the paramagnetic filings when a current of electricity is sent through the coils of wire, the core becomes a magnet but this only lasts as long as the current flows. When the current is stopped the filings will fall to the base. Note also here that it takes a strong current of electricity to attract the filings one inch.

4—Forms of Electricity. At present there are principally two forms, or voltages of electricity used. Namely: — Electro-static and electro-magnetic. To these might also be added, light, X-rays, violet rays, heat rays, radium rays and similar phenomena. Electro-static and electro-magnetic currents can be used in direct, direct pulsating and alternating currents.

5. Electro-static Electricity. In referring to electro-static electricity in this book, I refer to that form of electricity, whose electro-static attraction, repulsion and induction, seem to be greater than the electro-magnetic attraction, repulsion and induction of a given charge of current. This applies to electricity such as rubbing glass with silk, static machines, lightning, induction coils and other means to produce electricity, whose voltage is high enough to render the electro-static power greater than the magnetic. Electro-static electricity might be divided in two classes:—namely; electro-static electricity at rest and electro-static currents.

6.—Electro-static Electricity At Rest. When we electrify what is termed an insulator at low voltages, by friction or otherwise, by a positive or negative charge, if the insulator and the room be dry it will hold its charge for a long time. If there is the least bit of dampness present in the room, it is hard to get the

insulator to hold its charge, for as fast as it is charged it goes to the earth by conduction through the air and moisture which naturally gathers on the insulator. This is invisible conduction. Even in a warm, dry room the insulator can only be charged to a certain extent, as any excess voltage escapes through the air and insulator to the ground.

7—Electro-static Currents. If a positively charged body is brought near a negatively charged body, visible conduction will take place in the form of an electric spark. This is a small electro-static current. But strong static currents are obtained from static machines, secondaries of transformers, high voltage dynamos, electric arcs, and in many other ways. Electro-static currents play a very important part in

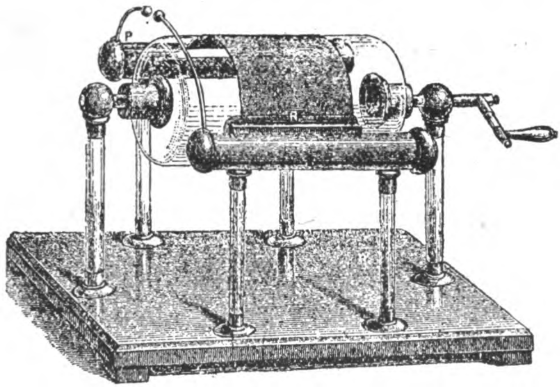

Fig. 2 Static Frictional Machine

wireless and should be studied thoroughly. These currents are necessary both for the sending and receiving apparatus. When two stationary charges of opposite sign are brought close enough for a visible spark, this seems to be only one side of the circuit, the other side of the circuit is through the air and intervening medium, by invisible conduction. It seems that there can

be no flow of electricity without a circuit. There can be no magnetism without an electric curernt. Even in a permanent magnet there is doubtless a direct current of electricity flowing somewhere without resistance. If a Leyden jar or condenser is discharged, the return circuit is surely through the glass or dielectric. A close anology of the condenser is the Tesla one-wire system. In a subsequent chapter I will show how the Tesla one wire system is a misnomer. In Fig. 2, is shown one form of a static machine.

8—Electro-static Attraction and Repulsion. In electricity there are two terms used, positive and negative. The Plus sign + is used for the positive and the minus sign — for the negative term. When a body is uncharged the positive and negative electricity are said to be equal. But when a body is charged by friction or otherwise, it is either positive, or negative. The positive charge being considered greater than the negative, hence the flow of the current is supposed to be from the positive pole to the negative pole. Bodies charged with positive and negative electricity attract one another. Bodies charged with negative electricity repel one another. Hence we have the law—like charges repel and unlike

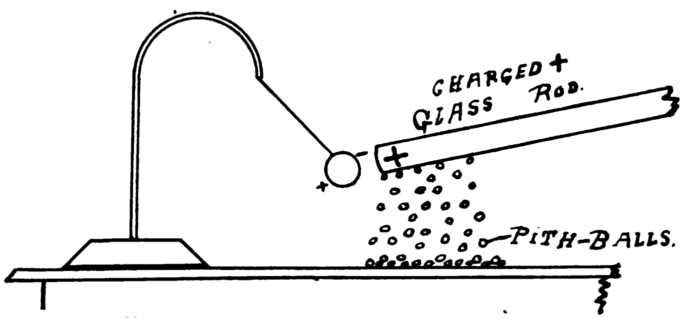

Fig. 3 Excited Glass Rod attracting small bits of Paper

attract each other. In Fig. 3, is illustrated the power of electro-static attraction. An excited glass rod is held about six inches away from light particles such as light pieces of paper; they are strongly attracted to the glass. I want the reader to note here that the electro-static power of attraction is several hundred times greater than the magnetic power of above charge, even when discharged through a high resistance electro-magnet. The same rule applies to Fig. 4 where the

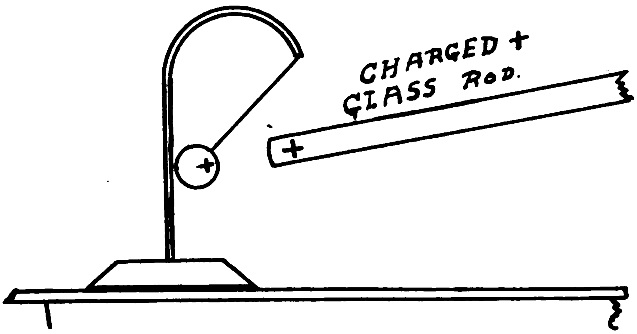

Fig. 4 Showing Power of Electro-static Repulsion

power of electro-static repulsion is shown. The magnetic repulsion o: a charge of electricity on glass, when passed through a high resistance electro-magnet, is almost nothing as compared to the electro-static repulsion of the same charge direct from the glass. Electro-static attraction and repulsion play a very important part in the reception of w reless signals and should be studied thoroughly.

9. Electro-static repulsion of a flame is shown in Fig. 5. If a candle is held near the negative pole of a static machine the flame is repelled, if held near the positive pole it is attracted. Heated gaseous conductors seem to be affected in like manner.

10—Static Density of Points. If a metallic point is connected to the knob of a static machine, which is in good working order and capable of giving a spark four inches long, a very short spark can only be obtained between the positive and negative electrodes. The electricity is discharged through the point almost as fast as it is made. Then it is conducted from the point to the ground through the air. This proves that even dry air is a good conductor for static electricity. It also shows that the electrical density of a point is much greater than any other part of a conductor. The air particles touching the point become highly electrified, and both the point and air being charged with the same kind of electricity, the air is repelled, thus causing a wind to flow from the point. If a flame is held near the point it will be blown aside. Also if the hand is held near, the wind can be easily felt.

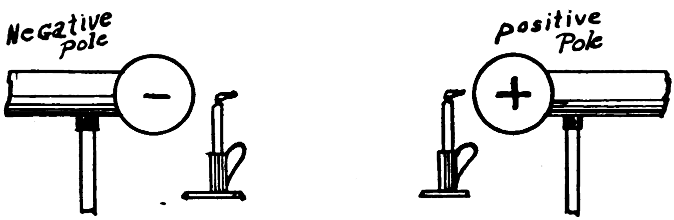

Fig. 5 Electro-static Repulsion of a Flame

This is better shown by Fig. 6, in which a plurality of points are bent in the same direction, and disposed so the wheel will turn. The force of reaction from the air causes the wheel to spin. This can be termed a static motor. Also another good way to discharge a conductor through the air is by a flame. Flames, heated currents of air, and currents rising from a red hot iron are extremely good conductors, and discharge electricity much better than points. Faraday found negative electricity to be much more easily thus discharged

than positive. Flames powerfully negatively electrified are repelled from a conductor but not so when positively electrified. Still another good way to discharge static electricity through the air is to attach one pole of a static machine to a wireless antennae and the other pole to the ground. Only very short sparks can be obtained across the knobs, if any at all. Also a

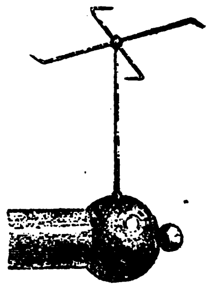

Fig. 6. The Electric or Static Motor.

spark coil that will give a spark one inch long across the spark gap, when the antennae of a wireless transmitting station is shunted across the spark gap will give only a very short spark across the gap. This tends to prove the conductivity of the air when an electrode of large area is exposed to the air.

11.—Electro-static Induction. If a charged body of electric ty be held near an unelectrified body, electricity of the opposite sign will be induced in it, caused by the law of electro-static induction, then both bodies will attract one another. If some substance be used that has a higher co-efficient of inductance than air, then the strength of the induced electricity is increased. Thus if an air condenser be filled with castor oil its capacity is said to be increased about five times. If the air was displaced by the solid selenium then the capacity would be increased ten

times. Below is a table giving the inductive capacity of different liquids and solids, when air is taken as one for a unit.

Dielectric	Inductivity value
Air at ordinary pressure, standard	1.00
Manila paper	1.50
Paraffine	(about) 2.00
Beeswax	(about) 1.75
Paraffined paper	(about) 3.50
Turpentine	(about) 2.25
Hard rubber	(about) 3.00
India rubber	(about) 2.40
Guttapercha	(about) 4.00
Olive and Neats Foot Oils	(about) 3.00
Castor Oil	(about) 5.00
Glass (Common)	(about) 3.00
Mica Sheet, Pure	(about) 7.00
Porcelain	(about) 4.70
Flint Glass	6.50 to 10.00
Selenium	10.00

Also if electro-static electricity is flowing through a closed circuit and a second closed circuit be brought close enough for induction to take place, electro-static current will be induced in the second circuit. If the currents are direct pulsating or alternating then alternating currents will be induced in the second circuit, although above circuits may not be in electrical connection. I also want the reader to note that the electro-static field reaches out in space much farther than an electro-magnetic field of a given current. The electro-static field caused by the electro-static currents is much greater than the electro-magnetic field, especially when tuned electro-statically. Electro-static currents should be closely studied as we have no other kind of current to deal with in the antennae circuit. Electro-static currents travel by conduction through

the natural media from a wireless transmitting station to the receiving antennae, electro-static currents being used altogether in the antennae circuit.

12—Electro-static Stress. The effects and cause of electro-static stress are little known at present. Here is a promising field for research. When a Leyden jar, which is illustrated in Fig. 7, is charged its volume has been found to increase, due to the expansion of the

Fig. 7. Leyden Jar

glass dielectric. Also when a glass tube is corked up at one end, filled with water, and a cork put in at the other end leaving no air space, then wires forced through the corks and in contact with the water, and a spark directed from a Leyden jar through the water; the glass is broken in many pieces, showing there was a sudden expansion of the liquid. Forces that can cause the expansion and breaking of glass are surely greater than the electro-static power of attraction. Although the electro-static power of attraction or repulsion of each molecule of the glass is probably the cause of the expansion of the water and glass. Many other substances seem to be thus affected; some contract in size while others expand. If electro-static stress is set up in all conductors, which I believe it is, electro-static stress must be considered in various wireless apparatus. For a force that can cause the expansion of glass, would certainly cause a direct current to travel through certain substances. A secondary effect of this electric stress is to produce heat.

As when a Leyden jar is charged and discharged rapidly the glass is noticeably warmed as can be felt by the hand. Then electro-static stress would produce both contact and thermo-electricity, if a loose contact of dissimilar elements were used. The polarity of these elements could be found by consulting tables of contact and thermo-electricity. This electro-static stress would no doubt cause a change in the electrical resistance of a single solid substance. This of course would be more marked in certain elements than others.

13 — Electro-Magnetic Electricity. In referring to electro-magnetic electricity in this book, I refer principally to that form or voltage of electricity, whose electro-magnetic strength is greater than the electro-static power. This form of current is a very low voltage as compared to static currents. But electro-magnetic attraction can be had from weak static currents if an electro-magnet of extra high resistance is used. But this electro-magnetic power is small as compared with the electro-static attraction of the same current. Before we can get any electro-magnetic power to speak of, we must use electro-magnets of extra high resistance in dealing with electro-static currents, as we must place in the circuit resistance before we can get the magnetic effect. All substances rapidly decrease in resistance as the voltage is raised. But in using currents of low voltage strong electro-magnets can be made by using only a few turns of wire, having only a few ohms resistance, whereas in static currents the resistance must be thousands of ohms to be most efficient. There are two main ways to produce magnetic electricity—chemically and by dynamos, although there are several other ways to produce electricity that are closely related to wireless, such as by contact, pressure, electro-static stress, thermo-couples and like means. Chemical electricity is better known as voltaic, and dynamo electricity as dynamic. Voltaic electricity is pro-

duced mainly by the chemical action of batteries. Dynamic electricity is produced mainly by dynamos. A single battery produces electricity at a voltage of about one and one-half volts. Although the voltage can be raised by connecting serially several batteries in a circuit. The voltage of static electricity ranges from about 30,000 volts upward. Dynamos can be wound to deliver many different voltages. The battery current is a steady direct current, and the dynamo can be made to produce both direct and alternating current. Direct current flows in one direction only, from the positive to the negative pole. Alternating currents first flow in one direction and then the other, this change of direction may occur many times per second. When this change takes place at low frequencies, such as 10,000 or less per second, it is better known as cycles. And when this change takes place at higher frequencies it is better known as oscillations, which in wireless reach millions per second, while for electric light and power the cycles are about 60 to 120 per second. These are considered low frequencies. I also note here that in low voltages a small amount of static seems to be always present. But the electro-magnetic power, to do a certain work seems to be much greater than the electro-static power. Below is a table showing the polarity of the most used elements when placed in chemicals to operate as a voltaic battery.

—	Sodium	Iron
	Magnesium	Copper
	Zinc	Silver
	Tin	Gold
	Cadium	Platinum
	Lead	Carbon +

The above list of metals is arranged so that any single element will be the negative pole of the battery when used with any element below it in the table, and the positive pole when used with an element above it. While there will be a difference of potential between carbon and iron, there will be a much greater difference of potential between carbon and zinc, in each case the zinc being the negative pole of the battery. In a battery made up of a zinc and copper electrodes, the zinc is the negative pole and the copper the positive pole.

14—Contact Electricity. It was discovered by Volta that when two dissimilar elements were brought in contact, a current of direct electricity was produced. This is more marked in some elements than others. It also seems that frictional electricity is contact electricity. If a positive and a negative element be brought into contact or the two elements rubbed against one another, a current of a direct nature is produced as long as the elements are rubbed together. It also seems that all heat is caused by electricity. Even the heat produced by friction in bearings is doubtless caused by electricity being generated by friction. Electricity is also produced by friction of like elements. One becoming positively electrified and the other negatively electrified. The polarity of the elements in contact electricity are generally opposite to the same elements when placed in a chemical bath. Magnetic and electric stress also seem to generate contact electricity, this will be explained better farther on. (See 'Electricity and Magnetism by S. P. Thompson'.)

15—Thermo Electricity. Thermo-electricity is produced in a closed circuit by heating or cooling a junction of dissimilar metals or elements. This was discovered by Seebeck in 1821. This is caused by the changing of the stress of the molecules at the unlike junction. All elements are made up of multitudes of

molecules if the tension or pressure of these molecules is changed an electric current is produced. Also a current of electricity will change the stress of the molecules, generating in most cases an opposing electro-motive-force. Electro-static oscillations will also change the stress of various elements, generating a direct current of contact or thermo-electricity. This latter law is the cause of the operation of crystal detectors in the receiving of wireless. Thermo-electricity might also be considered a form of contact electricity. It is not believed at present that crystal detectors are generators of a local current, but is claimed they are valves or rectifiers. The simple laws of static and thermo electricity causes even a crystal detector to amplify several hundred times the energy received in the antennae. Below I give a table and polarity of the most used and known elements of crystal detectors or thermo-couples.

Electro-Positive	**Electro-Negative**
Bismuth	Antimony
Bismuth	Tellurium
Bismuth	Selenium
Constantan	Copper
Galena	Plumbago, iron, copper, gold, or german-silver, etc.
Silicon	Gold, copper or steel
Nickel	Copper
Radiocite	Gold, silver or bronze
Zincite	Copper pyrites
Iron Pyrites	Steel or copper.

Below are substances that are both electro-positive and electro-negative. Substances in this class seem to be made up of electro-positive and electro-negative molecules. There are many substances or combination of substances that come under this head. I will mention only a few.

Carborundum (Carbide of silicon).
Hessite
Anastase
(probably, Iron-Pyrites)

I do not claim that above tables are infallible, as I have limited means to determine the polarity of above thermo-substances. There is a certain temperature that above substances will show the greatest generated current with a minimum change in stress. This stress can be changed by heat or electricity. But electricity and heat are closely related, as well as chemistry and electricity. Would some alloys made up of substances in the first table become both electro positive and negative? Here is a little explored field.

16—Electricity by Pressure. A large number of substances become electrified when under pressure. This includes many crystals and metals. Even certain insultators become electrified when compressed.

17—Conductors and Insulators. Bodies which allow electricity of low voltage to flow easily through them are termed conductors. Bodies which resist the flow of low voltage currents are termed insulators. Though in using the best conductors for low voltage they offer some resistance. Likewise when using the best insulators for low voltage currents, they allow some of the current to leak through by conduction, even when the lowest voltages are used. So the law for conductors and insulators at low voltages is that there is no perfect conductor or insulator. Below is a table giving the best conductors and insulators in their respective orders for low voltage currents.

Conductors	Insulators	
Silver	Dry Air	Wool
Copper	Glass	Porcelain
Other Metals	Paraffin	Oils
Charcoal	Ebonite	Paper
Plumbago	Shellac	Marble
Damp Earth	Guttapercha	Dry Wood
Water containing Solids	Rosin	Cotton
Moist Air	Silk	

Science needs tables showing the relative conductivity and specific resistance of above elements at many different high voltages. Also at different higher temperatures. Under the chapter of condensers I will try to show how many kilo-watts of currents flow through glass.

18—Electro-Magnetic Induction. These low voltage currents when traveling a circuit will induce, by electro-magnetic induction, currents in another parallel circuit though they may be insulated from one another and have no electrical contact. When the current is made in the first or primary circuit, a momentary direct current is induced in the second or secondary circuit. When the current is broken in the primary circuit, a stronger momentary inverse current is induced in the secondary circuit. So if some means is used to interrupt the primary circuit many times per second, a seemingly steady current is induced in the secondary circuit. But if examined by a rotating mirror the sparks are in groups and correspond in their rate of alternation by the interupted primary circuit. As long as the current remains unchanged in strength in the primary circuit no current is induced in the secondary circuit. If the strength of the current is increasing in the primary a direct current is traveling in the secondary. Also if the strength of the current is decreasing in the primary, an inverse current is travel-

ing in the secondary. By a direct current here I mean a current that is traveling in the same direction as the current in the primary winding. In Fig. 8 is shown a diagramatic drawing of a modern induction coil. Around the core 2, is wound a primary winding of a few turns of relatively heavy insulated wire, and connected in series with a key, battery and mechanical vibrator 5. A condenser 6 is shunted across the contact of vibrator, so as to allow the high self induced current in the primary winding to short-circuit through the condenser dielectric. This self induced current is of an enormous high voltage and will travel through the high resistance of the condenser with ease. Owing to the high resistance of the condenser the low voltage current is held back and caused to go mainly through the contacts of the vibrator. In a sense this condenser acts as a valve. It will allow a large portion of the induced high voltage currents to go through but holds back nearly all of the low voltage of the battery current, causing it to go mainly through the vibrator contacts. A secondary winding 3 of many turns of small

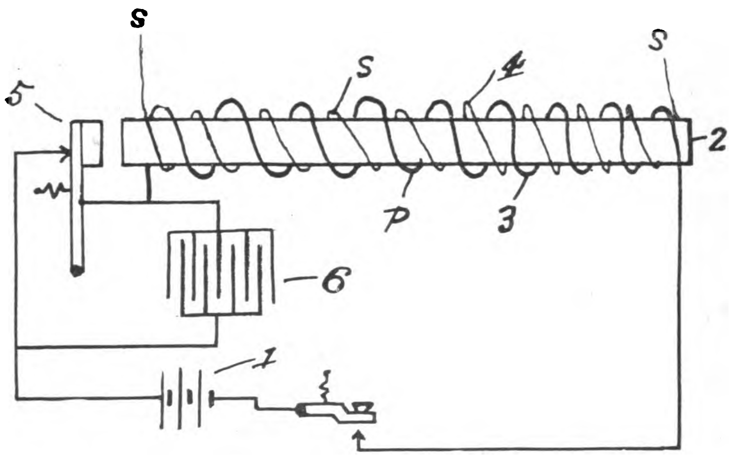

Fig. 8 Diagramatic Drawing of an Induction Coil

insulated wire is wound around the primary winding and the core, and from these two terminals the high voltage current is obtained The ratio of the voltage of the secondary circuit is in proportion to the number of turns and size of wire as compared to the primary winding and voltage. In large coils an enormous voltage is obtained, 150,000 volts or even higher. By the ratio of winding almost any voltage can be obtained regardless of the voltage in the primary. The secondary voltage can be made so high, that seemingly the

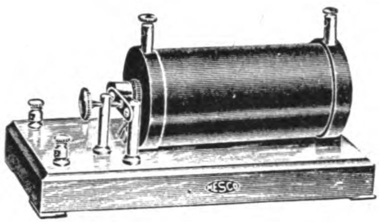

Fig. 9 A Modern Induction Coil with Condenser Mounted in the Base

current no longer will follow conductors at low voltages. This is because the air is about as good a conductor as metals. The windings can be wound so that the primary current will either step up the primary voltage or lower it. Induction coils are also called transformers. In Fig 9. is shown a picture of a modern induction coil.

19—Measurements of Electricity. The pressure of electricity is measured in volts. The amount of the current traveling by amperes. The total electro motive force is measured in watts. Watts equal the product obtained by multiplying the amperes by the volts. The resistance of an element to the flow of electricity is measured in ohms. To find the volts of a current divide the watts by the amperes. To find the amperes of a current divide the watts by the volts.

20—Ohm's Law. The relation between electro-motive force, current strength, and the resistance of an electrical circuit is disclosed by Ohm's law which states that the strength of a current in amperes in any given circuit is directly proportional to the electro-motive force and inversely proportional to the resistance. By Ohm's law any mathematical problem can be worked out in relation to resistance and electro-motive force of any given circuit or current.

21—Gravitation. I hardly believe that a brief explanation of the elementary laws of electricity and magnetism would be sufficient without an article on gravitation. There are three forces in Nature that seems to be indentical to a certain extent, namely:—Gravitation, magnetism and static. We know that electricity is the cause of magnetic and static attraction and repulsion. I have noted that some scientists think that gravitation is magnetism. I don't see how this could be, as diamagnetic and paramagnetic elements are attracted to the Earth in like manner.

Also the Earth does not affect the compass needle only in an indirect way which I will point out in a subsequent chapter on Earth Currents. The attraction of static electricity seems to be a better explanation. as both diamagnetic and paramagnetic elements are attracted in like manner. One can only imagine what the electro-static power of attraction of the Earth and air could be if strongly charged with electro-static electricity. The inductive power of the Heavenly bodies, if charged statically might reach across the millions of miles of space which separate them. But when we learn that a sheet of metal placed between a body statically charged and a body uncharged, induction does not take place. But then the electro-static field could be so great as to act in transverse directions, similar to the pressure of the air. I would not say

that the cause of gravitation was static attraction, but I suggest above as a seemingly better explanation than magnetism. Also the laws of gravitation and gyroscopic action seem to be similar. Electro-static attraction might be partly the cause of the tides. While I believe gravitation is the dominating force that holds the Universe in its rotational path, electro-static power of attraction might be a secondary effect. I only mention above to help start others thinking on the subject, as here lies a promising field for research. I have had to make this chapter much more brief than I would like. But I refer the reader to any of the well known books on elementary electricity and magnetism for more complete explanations.

CHAPTER II.

EARLY METHODS OF SIGNALLING BY WIRELESS.

22—Ground Conductive Method. In early days there have been many primitive ways of signaling intelligence over short distances both visible and audible. But the first method to signal electrically

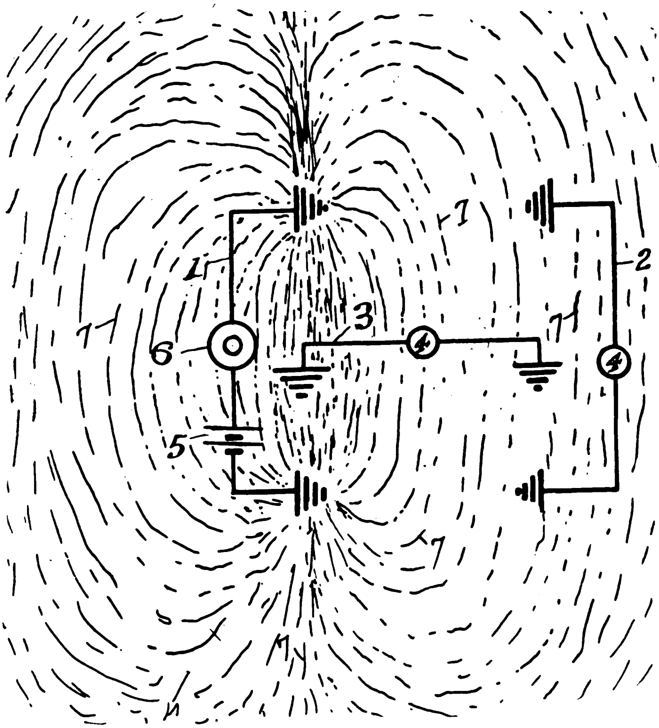

Fig. 10 Ground Wireless Conductive Method

was the ground conductive system. This is better explained by referring to Fig. 10. This system used a grounded circuit for transmitting, having connected in series a low voltage battery 5, and telephone transmitter or current interrupter 6, this constitutes the sending means. The receiving means is a grounded circuit 2, having connected therein serially a telephone receiver 4, the direction of this circuit should be in the same plane as the circuit 1, or conductive currents 7. If a similar grounded circuit 3 is disposed at right angles to the lines of current 7, very little, if any, signals can be received. These lines of conduction 7, are similar in form and direction, to the lines of force from the poles of a bar magnet. The action of this system is as follows:—If a person talks into the transmitter, electric pulsations of direct current are set up in the grounded circuit, the ground here acts as a return circuit or shunt for metallic wire 1, but as this shunt offers some resistance to the passage of the current it cannot all go in a direct line from one ground wire to the other, and all the surface of the earth for long distance in every direction will take its share of currents according to the laws of conduction and divided circuits. These currents are shunted by the earth and generally take the directions as lines 7. Now if a parallel wire is grounded at both ends and disposed in the same plane as the transmitting circuit or lines of conduction, and a telephone receiver is connected in series with the receiving circuit, then a portion of these earth currents will travel the receiving circuit according to the laws of conduction and divided circuits. The voice can be thus heard in the telephone receiver though the receiving circuit may be several thousand feet away. Intelligence can be thus transmitted in the form of telegraphy or telephony, though no wires connect the two circuits together. This system was discovered and developed by Morse, Steinheil and Preece. But with this system and ap-

paratus used the system is limited to short distances such as three or four miles, mainly because the receiving apparatus is limited to the electro-magnetic power of weak currents. But if, instead of sending out a low voltage current, we send out electro-static currents and electro-static detectors are used in the receiving circuit, then we have the ground wireless as is used today, and patented by Dr. Rogers. By the latter method signals have been transmitted and received over 100 miles. But if the receiving ground circuit be used to receive from air antennae, then messages can be received by ground wireless half way around the world. In receiving ground wireless the metallic wire should be insulated and disposed close to, on top of, or under the ground, also to permit of closer tuning condensers, should be connected serially.

23—Electro-static and Electro Magnetic Induction Method. This method operates on the well known principles of electro-static and electro-magnetic induction, and is simply large electro-magnets with an air core. This is better explained in Fig. 11. Two large coils of wire are used, one coil

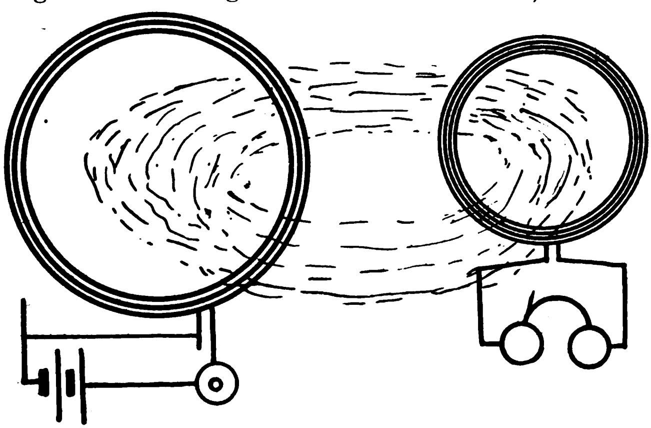

Fig. 11 Electro-static and Electro-magnetic System

which is used as the transmitting coil is composed of about a dozen turns of large wire wound in a circle, having a diameter of about 3 feet. Connected in series with this coil is a telephone transmitter and battery of about 20 volts. The receiving coil consists of about 60 turns of small wire, and about 2 feet in diameter, connected in series with a telephone receiver. When the telephone transmitter is talked into a strong electro-static and magnetic field exists at right angles to the transmitting coil. If the receiving coil is disposed at right angles to the lines of magnetic force then the telephone receiver will respond and the diaphram will vibrate in unison with the transmitter diaphram.

If an interrupter and key is used instead of the telephone transmitter then the buzzing signals can be heard in the telephone reeeiver. But the distance of this is very limited as only distances of about 40 feet can be covered. Note that the receiving coil must lie in the same plane as the transmitting coil. Also I would like the reader to note that it makes no difference which side of the coil is turned towards the transmitting coil, the signals are of the same strength. Also if both of these coils be grounded the distance at which a person can talk will be increased, because we have here both conduction and induction as the dominating factors.

24—Audio Frequency System. This method esembles very closely the Hertzian wave signalling as used today, as both sending and receiving stations use an elevated antennae in either system. The audio-requency system is better known at present as the system of electro-magnetic and electro-static induction. But my experiment and study show that this system and the conductive system described in Art. 22 work on the same principle, as both systems use the natural media for conduction. This is Prof. Dolbear's invention of wire-

less telegraphy and a close analogy to the conductive system invented by Samuel Morse. The principle of operation of this system is better described by the drawing in Fig. 12. The primary of the induction

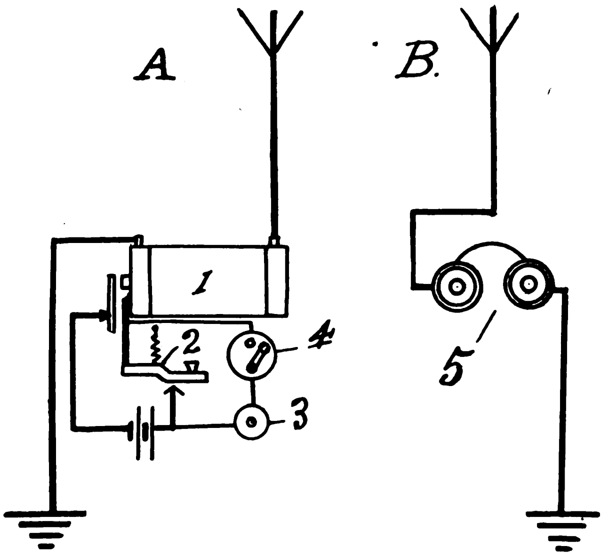

Fig. 12 Prof. Dolbears Audio-Frequency System

coil 1 has connected in series an interrupter, battery and key 2, one side of the secondary being connected to the ground and the other side direct to the antennae. The receiving apparatus consists of a telephone receiver connected in series with the antennae and ground. This constitutes the sending and receiving apparatus of the Dolbear system of wireless telegraphy. When the key is depressed a buzzing sound can be heard in the telephone receiver, provided the antennae are not too far away. When the high voltage induced current from the secondary winding goes up the antennae the resistance of the air is broken down and

the current travels in every direction from the antennae by conduction in electric waves. When these electric currents travel through the air they will seek the least resistance for return to the ground to complete the circuit, and if an antennae placed in their path according to the laws of conduction a portion of the energy will short circuit through the antennae and telephone receivers to the ground, thus causing the receiver diaphram to vibrate by magnetic action of the currents, and audible sounds are sent out. If instead of using a telegraph key in this system, a switch and telephone transmitter are substituted then we have a wireless telephone system. This will not work as far as the telegraph system. In using an induction coil as a wireless telephone transmitter the vibrator must be screwed down tight or shunted by a wire. But this system is like the first conductive system mentioned in Art. 22, it is limited to the electro-magnetic power of the transmitted currents sent out from the transmitting station. Prof. Dolbear could only send about 2 miles when using very high aerials, with the apparatus he used. But with the apparatus that is in use now, messages can be sent around the world with this system. If vacuum tubes and Alexanderson magnetic amplifier be used to modulate speech, and using high power current and transformers, this system will talk around the world when using an audion cascade amplification for reception. How many believe that an electro-static or electro-magnetic field can be made to reach around the world. It seems to me that conduction is a far better explanation. The above systems were not subject to tuning and the distance covered was small in comparison to the energy used. Scientists were naturally looking for a more efficient and better system. There were many working in this direction.

25—Work of Hughs. Probably the future will honor Prof. Hughs as the first inventor of the electro-

static system used today. In 1879 he was experimenting with a loose contact microphone close to an induction coil. He noticed that every time the coil was operated a buzzing sound was heard in the telephone receiver. Even if the microphone was several feet away from the coil and no connecting wires used.

This caused considerable excitement at the time, especially among scientists. Prof. Hughs thought that this device detected invisible electric waves going through the air by conduction. But scientists discouraged him, expressing doubts as to the invisible electric waves. So later he succeeded in sending wireless signals quite a distance, but became discouraged and gave up. So doubtless here is a lesson for scientists not to discourage any new ideas or theories if even at the time they seem an impossibility. If science had encouraged and helped Prof. Hughs we would have been living in a different world today.

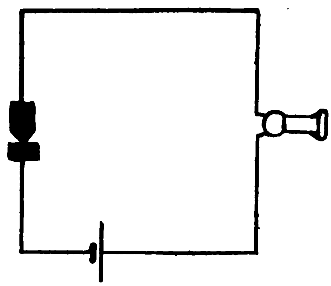

Fig. 13. Prof. Hughs Microphone Detector of 1879

In Fig. 13 is shown the microphone detector as used by Prof. Hughs who is undoubtedly the first inventor of a wireless detector.

26—Work of Hertz. It was about the year 1888 when a German physicist, Heinrich Hertz, made some experiments that were of untold value to science by confirming in an experimental way the theories of Maxwell, that wireless waves and light were similar.

While he thought these wireless waves, when detected at a distance from an induction coil was by electro-magnetic induction alone. Science quickly accepted this theory and here was the beginning of the system of electro-static oscillations as used today for the transmission and reception of intelligence around the world. Prof. Hertz used a coil of wire, and when placed in a conductor of strong invisible electric currents, enough electricity was conducted to the coil to produce a visible spark when the two ends of the coil were close together. When this coil was close to the spark gap of the induction coil electro-static and magnetic induction was no doubt the cause of part of the current in the Hertz coil. But the air acting as a conductor for the invisible electric waves was by far the greater and dominating cause. But this electro-static and magnetic field only exist a very short distance from

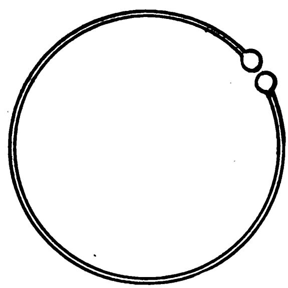

Fig. 14 Hertz Resonater

the induction coil of wireless transmitting station and the electro-static currents travelling by conduction through the air are the sole cause of our wireless detectors responding to same. The electro-static and magnetic field quickly dies out. This is confirmed by the elementary laws of electricity. In our wireless currents today we are not dealing with the induction of same, but by their direct action by conduction through the natural media, as the dominating cause. The Hertz coil or resonater is illustrated in Fig. 14.

27—Work of Tesla—Shortly after the discovery of Hertz, Tesla published a book predicting the ultimate transmission of wireless energy for power and the transmission of intelligence. And also patented systems of the transmission by wireless of high voltage currents. Tesla is considered the Father of Wireless. It was he who developed high frequency, high voltage oscillating currents to their present degree of perfection.

28—Work of Branley—Calzecchi Onesti discovered that metal filings could be made to cohere by the sudden discharge of a Leyden jar at a distance. The laws governing this phenomenon were formulated by Branley in 1890, who produced a filing coherer that was sensitive to Hertzian waves at a much greater distance than the Hertz resonater. Dr. Lodge improved upon this device by enclosing the filings in a vacuum, and applied it to the principles of electrostatic resonance. When the Hertz waves went through the metal filings they cohered together and their

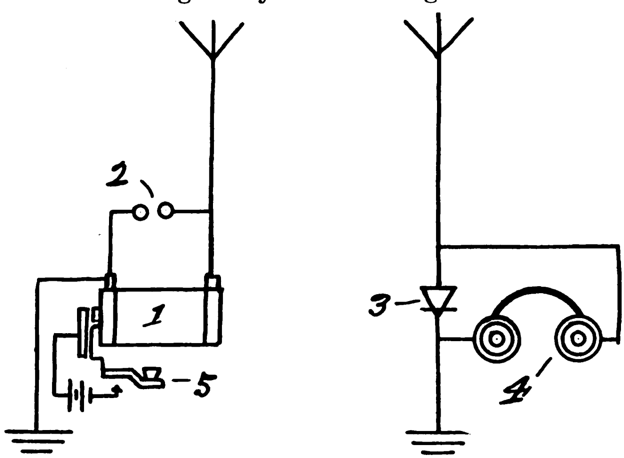

Fig. 15. Marconi Wireless System

electrical resistance was lowered, a battery current varied thereby. But after the static oscillations stopped the filings still cohered by the magnetic action of the current flowing through the paramagnetic filings, but tapping the container would restore them to their original high resistance.

29—Work of Marconi. Marconi was one of the early experimenters in developing a wireless system that would span great distances. His most valuable contribution to the art no doubt was applying the electro-static oscillations to the Dolbear system of elevated aerials connected to the ground through the spark gap. As shown in Fig. 15, When the key 5 is depressed, induced currents of high potential are set up in the secondary of the induction coil 1, which is shunted by the spark gap and antennae circuits, oscillations are set up in the antennae circuit which oscillate in some wave lengths over a million times per second. This constitutes the transmitting apparatus. The receiving apparatus consists of a similar aerial and ground but in it are connected a coherer 3, in series with a telephone receiver 4. This constitutes the simplest receiving apparatus. Of course Marconi in his early experiments used a para-magnetic coherer that had to have a mechanical means of tapping to decohere after each signal was received. I have not shown this here as it can be found in most of the wireless books. I would like the reader to note the similarity of this system and Prof. Dolbear's, described in Art. 24. The principle of transmission in both of these systems is surely the same. One system sending out audio frequency waves and the other sending out radio-frequency waves. The difference is certainly not in the principle of transmission, but in the form of the currents transmitted. Marconi demonstrated to science that the distance at which radio signals could be transmitted, was only limited to the powers and apparatus used. When the power was increased the distance

of signalling was increased. And in a short time he succeeded in sending wireless messages across the Atlantic ocean. To Marconi belongs the credit for the practical wireless radio system that is in use today. This system can be described as Hertzian wave, electro-static or radio-frequency. This system is better known as Hertzian wave, in honor of Heinrich Hertz who started its rapid development.

30—Electro-magnetic Waves. The present theory of the transmission of wireless is that there is an electro-magnetic field created at right angles to the transmitting antennae and travels in all directions at the rate of 186,000 miles per second. And if these electro-magnetic waves strike a conductor they will induce in it, by the laws of electro-magnetic induction, currents, that correspond with the currents in the transmitting antennae. This electro-magnetic theory is considered the dominating cause for the transmission of wireless, and that all of the energy that flows in an antennae is caused by electro-static and electro-magnetic induction. This is a brief explanation. For a more complete explanation I refer you to any of the wireless books now on the market. But I would like to bring out that nearly all of the original theories have changed on wireless, to a certain degree. Such as changing the thermo-electric action of crystal detectors to rectifiers. Also a few years ago it was generally stated that the energy of the current that went into the ground from the transformer and spark gap was dissipated into heat, but since the publication of the Rogers ground antennae, I believe this theory is regarded by all as obsolete. But the original electro-magnetic theory is still applied to the air. The generally accepted theory now is that wireless travels through the air by electro-magnetic Hertzian waves and through the ground by conduction, or that the electro-magnetic waves gliding through the air, induces by induction, currents in the ground.

CHAPTER 3.

SUMMERS' THEORY OF WIRELESS

31—Introduction. In the winter of 1904-05 I helped some to erect a De Forest station in Fort Collins, Colorado. I thought then that wireless telephony was possible. So the following summer at my home in Missouri, I carried out a number of experiments. But always experimenting with the view that the air was a conductor for the electro-static currents. I will mention some of the experiments I carried out in the summer of 1905. First I tried wireless telephony. I connected the transmitters direct in the primary winding, and could talk quite a distance with this, but I found it would not work a coherer or crystal detector. But when the telephone receiver was connected direct in the aerial the speech was reproduced perfectly. I used an aerial connected with one end to a windmill tower. Also aerials connected to trees and from poles set up for the purpose. I could put the receivers on my head, hold one of the receiver terminals, and I had the other soldered to a piece of gas pipe, about 6 feet long. I held the gas pipe in the other hand insulated by a piece of rubber. In walking in different directions I could hear quite a distance a phonograph playing a piece of music close to the transmitter. I also noted when I went under trees the sound in the receiver was entirely shut off as I expected. So I drove a nail in the tree and held the gas pipe on it and I could hear plainer than ever. So I thought I would try the tree as an aerial for the Hertzian wave system, and I had the same results. I also tried the telephone transmitter direct in the antennae. I used a crystal detector, but the voice from the phonograph was broke up. Until then I thought the spark from a spark coil was made up of alternations that would not

be audible to the ear. So I knew that if the microphone-in-the-earth-connection was a success, more rapid sparks would have to be used. I had brought home a number of bright pieces of iron pyrites that came from Idaho. I was using one of these for a microphone contact because it was bright. I tried to receive Hertzian waves with this connected in series with a local battery; it was a success. I noted that if the current was sent in a certain direction the signals were stronger. Once I made a mistake and connected both wires to the same pole on the battery, the signals were weak and I could not tell the reason for a while. So when I saw that the device worked with both wires to one pole, I disconnected both wires and the signals were just as strong. I thought at the time it was a part of the wireless currents traveling through the air that caused the vibration of the telephone receiver. But when I tried a resilient needle contact on carbon it did not respond, except when a battery current was used. I did not realize that this was a more efficient detector than the electro-lytic detector as used then by the American De Forest Company. I believed all the time that the electrostatic power of attraction was the cause of the action of detectors. I employed the needle point principle of high static density to a loose contact. I also tried to apply the static repulsion principle of a flame to an incandescent lamp, but failed at the time. I carried out many other experiments in above mentioned year. I might also mention that I used step down transformers for receiving with the audio-frequency system. Then for several years I did not give much time to wireless but later purchased more books on the subject and kept up my study. But I could not believe the theories which they advanced. I could not apply the actions of my inventions to the theories contained in the books. Always experimenting and studying with the electro-static conduc-

tion and reception view in mind, many improvements flashed through my mind which are in use today. I wrote a letter to a certain editor of a well known paper, in regard to the wireless messages traveling by conduction through the ground, trying to get him to publish them. He answered me by saying that it was impossible for the currents to travel in the ground, for as soon as the current struck the ground plate it was dissipated into heat. Of course I could not believe this, so in 1914 I sent to the Manhattan Electrical Supply Company of St. Louis, for about 300 feet of lead cable. I thought I would see if the currents did travel in the ground. I buried this cable so I knew that no energy from the air could affect it. I put one end of this cable in a cellar, and connected a detector up in the cellar to the cable. About twenty rods from the other end of the cable I put up a small wireless transmitting station using a one inch spark coil, with the key tied down. Then I went into the cellar and heard plainly the wireless signals from the cable. I connected the detector to both the insulated wire in the cable, and to the lead covering, but when connected to the lead covering the signals were the strongest. Then I was sure that wireless traveled through the ground. I then made a drawing and wrote an article describing the drawing in the early part of 1915. I tried to get several well known electrical papers to publish this. I received some interesting answers in regard to it, but they all refused to publish it. I believe if they had published it, ground and tree wireless would have been here several years sooner. I did not realize the importance ot ground wireless. I never thought it was patentable in view of the systems used by Morse, Steinheil and Preece. I laid the cable in an east and west direction, and it is still there. In the early part of 1916 I copyrighted the drawing which is described in the next article as I first wrote it in 1915.

32—Description of 1916 Copyright. Every particle of air becomes charged with Electricity that is within range of a wireless transmitter. Air being a fairly good conductor for high voltage currents. The

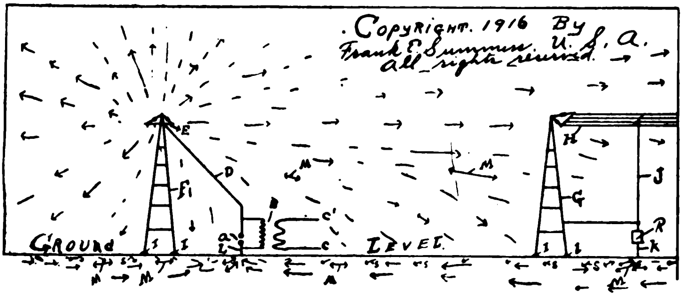

Fig. 16. Illustrating Conductivity of the Air

circuit is composed of the air and ground. In the drawing (Fig. 16) F and G are wireless towers. The transmitting tower is designed by the letter F and receiving tower by the letter G. The conductors C and C conduct alternating or vibrating currents to transformer B. This current is stepped up to a high voltage by transformer B. This high voltage current is carried from the secondary circuit by a metallic circuit to spark gap A. One side of secondary circuit is connected to the antennae E by the metallic wire D. The other side of secondary is conducted to the ground by the metallic wire L. The spark gap circuit A is bridged across the secondary circuit. Also the circuit composed of the aerial conductor D, the ground wire L, the antennae E and the air between the antennae and ground is also bridged across the secondary circuit of transformer B. The high voltage current from the secondary of transformer B has two paths to travel to complete its circuit, which is through the spark gap A and the air and ground. Each circuit or path will take its share of current according to the laws of resistance. Also according to the laws of resistance

that part of air directly under or near the antennae E will conduct much more current to the ground than the air that is farther away. And for this reason sending tower should be insulated from the ground, as shown at I. Also the antennae E should be insulated from the tower in sending and in metallic connection when receiving. Some of the arrows shown in the drawing are pointed on both ends indicating alternating or oscilating current traveling both ways or in both directions. The current radiating from the antennae must seek the ground to complete its circuit through the air, and travels as arrows indicate in every vertical and horizontal direction from the antennae. Every particle of air within range of the sending power of transmitting station is charged with electricity. of course as distance increases, resistance increases and the air is charged less. When the air is charged it will seek the paths of least resistance to return to the ground, such as a wireless receiving station as I show at tower G, antennae H, lead in wire J, receiving apparatus R and ground wire K.

Every substance extending up in the air receives current in proportion to height and conductivity. Such as trees and buildings. This is the reason messages are hard to receive in steel frame buildings.

According to the laws of resistance the higher the antennae is above the ground the farther a message can be transmitted. As the resistance between the antennae and ground becomes more, it is evident that signals will travel further.

Also according to the laws of conduction the mixture of gases called air, will allow high voltage current to pass easily through it. Wireless signals travel through the circuit composed of the air and ground, just the same as electricity travels through a metallic circuit. (See Art. 40).

33—Conduction Theory. The present theories of Hertzian wave propagation of electro-magnetic waves are wrong. The present theory being a detriment to the advance of the wireless art.

The transmission of wireless energy is purely electric or electro-static waves. The air acting as one side of the circuit and the ground and the ocean the other. The air becomes an excellent conductor for the high voltage current of high frequency. This is also helped by the well known fact that the first few feet of the air next to the ground acts as an insulator for electricity. The resistance of the ground, ocean and air is hardly anything to the passage of high voltage current. The speed being about the same as light. The air acting as a conductor is the reason that the higher the aerial the farther messages can be transmitted with the same energy. This is also the reason that the tower and aerial will receive better when in metallic connection. The aerial will transmit farther when it is not in metallic connection to the tower. This is also the reason that an umbrella type of aerial will receive better than transmitting. A high flat top aerial will send farther because not so much of the energy is short circuited to the ground as when an umbrella type of aerial is used. The earth and air act as a conductor for wireless energy. This is the reason messages will travel farther over the ocean. The air is full of moisture and a trace of salt making the air over the ocean a much better conductor than air over the land. This is also the reason that in dry climates it is harder to transmit wireless, the air being a poorer conductor. This is also the reason that wireless can be transmitted farther after night, the air being a better conductor as more moisture is in the air after night. (See Art. 99.)

34—Airplane, Submarine and Ground Wireless. The air acting as one side of the circuit for wire-

less and the earth and the ocean the other. It is evident that if a wire of conducting material be placed in one of above mediums, according to the laws of electrical conduction and resistance a small portion of the message will travel the wire. If wireless transmitting and receiving apparatus is placed in or connected to this wire, messages can be transmitted and received by airplanes flying in the air or by submarines under water. Also if a wire be connected to the ground at one place through a condenser and the other end at a distant place and a wireless transmitting and receiving apparatus be connected therewith, messages can be transmitted and received by ground wireless. The principle of the just mentioned ground aerial is the same as used by Steinheil of Bavaria and developed later on by Preece. In both systems conduction is means of transmission. The air and earth acting as a conductor for wireless currents is the reason that an aerial disposed in the plane of transmitting station will give best results as receiving. If an aerial is disposed at right angles to the transmitting station, it will not respond even if of the same wave length. This is because the wireless current flows at right angles across the aerial, and not enough current can travel length ways with the aerial to affect the receiving apparatus. This applies to water and ground aerials. The principle of transmission in all are the same conduction. (See Art. 22.)

35—Electro-static Theory of Detectors. In general the present theory of the valve action of electrolytic and crystal detectors is undoubtedly wrong. In those detectors where a local current is used, the action seems to be the altering of same by electro-static repulsion, attraction and stress. In crystal type of detectors a local direct current seems to be generated by the laws of electro-static attraction, repulsion and stress. In the type of detectors and amplifiers known as Flemming and De Forest audion

vacuum tubes, the dominating principle involved is electro-static repulsion of a flame, air, hot conductors of air, vapor, white hot wire, hot conductors of vacuum and certain gases. In all forms of present detectors I don't believe any of the received energy from the aerial is used to operate the telephone receiver, except by electro-static relay. The pulsating direct current in the telephone receiver circuit is of much more electro-motive-force than that received in the aerial. It is also of much lower voltage. My experiments tend to show that all of the present forms of detectors are electro-static relays and amplifiers.

36—How Electric Waves Leave an Antennae. If the air could be sliced across an aerial, and a photograph taken of the waves they would appear similar

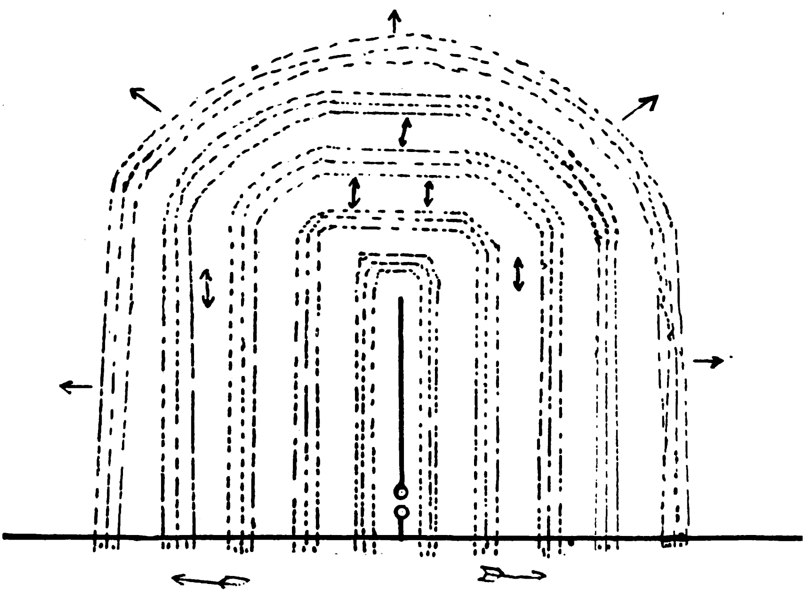

Fig. 17. How Groups of Oscillations leave the Antennae

to Fig. 17, leaving the antennae in every direction. Here is shown five sparks which cause five groups of oscillations to leave an aerial in every direction. These electric waves travel by conduction in positive and negative charges. In traveling long distances, as when sent out by a high power station the strongest lines of currents travel through the ground and rarefied air several miles high. The air in between tends to short circuit the currents. So if an aerial is disposed for receiving it will take its share of current according to the laws of conduction. When wireless currents travel long distances they will take the lines of least resistance, which is through the ground and rarefied air. The aerial acts as a partial shunt for the wireless currents. But since there is not much difference between the resistance of this shunt and the space of air far beyond, so according to the laws of conduction a large portion of the current will spread out through space in every direction. Suppose that there were clouds several miles in one direction from a high power wireless station and it was not raining any where from these, and in the other direction it was clear, the messages would certainly be the strongest in the direction of the clouds, as the moisture in them would conduct better. This might account for some of the freak distances which can be covered some times. Light seems to render the air a better conductor in a sense, as light seems to short circuit the messages by ionizing the air. The upper layers of air also have more moisture in them at night. So messages can be sent much farther in the night than in the day time. The ultra-violet rays of light will discharge conductors negatively electrified. Also the rays of light seem to polarize wireless electricity. I believe these laws are mainly the cause for better wireless transmission after night. For a further explanation of this subject see Chapter on Light.

The form of open circuit antennae system is far more efficient than a closed one, the idea that an open or closed circuit can cause an electro-static and electro-magnetic field to reach around the world direct, seems to me an utter impossibility and against the elementary laws of electricity, which I believe the near future will prove.

37—Directive Antennae. When the vertical antennae is used it will receive and transmit the same in all directions, but when an inverted L antennae is used it will transmit and receive the best opposite to which the free ends point. I will try to explain this by the conduction theory. In Fig. 18 I show an antennae of this type. Five groups of oscillations are leaving the antennae. If conduction is the cause of transmission then the electric waves that leave the

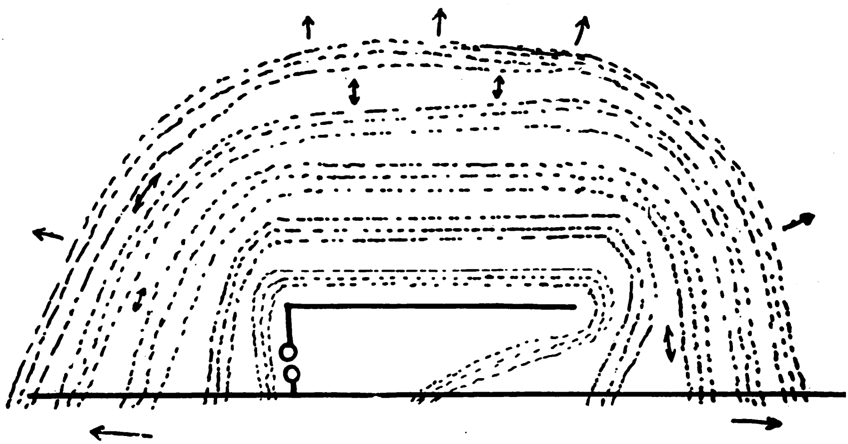

Fig. 18. Directivity of an Inverted L Antennae

under side would become quickly grounded, those waves that start in a vertical direction are the effective waves, the lines of conduction of these will natur-

ally take the form as shown, from the free end back to the ground on the other end, consequently the lines of conduction are strongest opposite to which the free end points. These lines of force seem to travel faster at the foot of the waves than in the air so when they strike an antennae pointing in the opposite direction more lines of conduction are cut than when the free end points towards the transmitting station. The ground being a better conductor than the air for electricity certainly causes the foot of the electric waves to advance faster.

38—Airplane Wireless. In airplane wireless the ground can not be used, so instead we must use two antennae, one connected to each side of spark gap or its equivalent. In airplane practice generally the metal parts of the airplane and wires disposed on the plane and connected to the metal parts, consti-

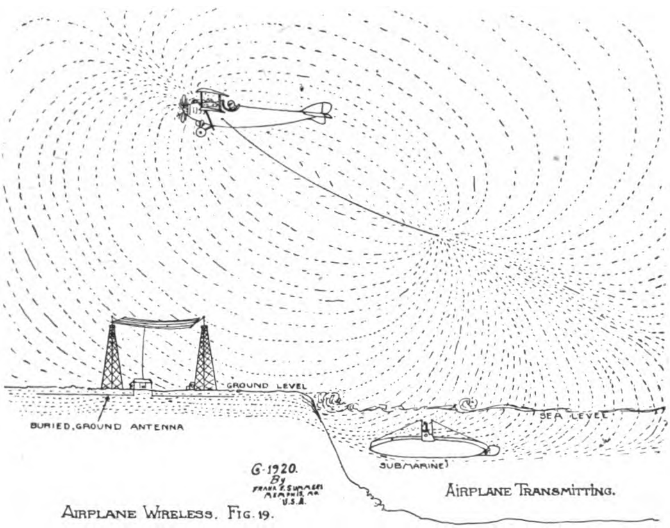

Fig. 19—Airplane Wireless

tute one antennae, bare wire trailing several hundred feet behind is used for the other antennae. This trailing wire is of course insulated from the metal parts of the machine. Now if the air was a non-conductor for electricity, these two antennae would represent an open circuit. But I contend there can be no flow of electricity without a circuit. So apply the conduction theory to these two antennae or electrodes the lines of conduction will be similar to those shown in Fig. 19, and correspond to the present direction of strongest transmission of airplane wireless. Also the higher the airplane, the better conductor the air is because the air is more rarefied. Now when a flying machine of any type is traveling in a medium which is a conductor of electricity there is more or less danger from gases being ignited. Both from the wireless transmitter of its own or from other stations. No doubt many an airplane and dirigible type of flying machine have been destroyed from this cause, in the late war. But I believe the most danger is from the flying machines own wireless transmitter. But there is no doubt that the wire and metal part of a flying machine will have large enough area to conduct from the air long sparks even when many miles away from their source. All metal parts of a flying machine should be in metallic connection, and no conducting points exposed to the air or gas medium.

39—Submarine Wireless. As I have previously pointed out it matters not which of the natural media is used, conduction is the means of transmission, whether it be the air, water, ground or a combination of same. I show in Fig. 20 a submarine transmitting the lines of conduction, from the closed loop antennae, will take a general direction similar to the dotted lines. According to the laws of electricity of a high potential the closed copper circuit cannot shunt all of the current, neither can the water above the antennae, and so the air above the water shunts the rest of the current,

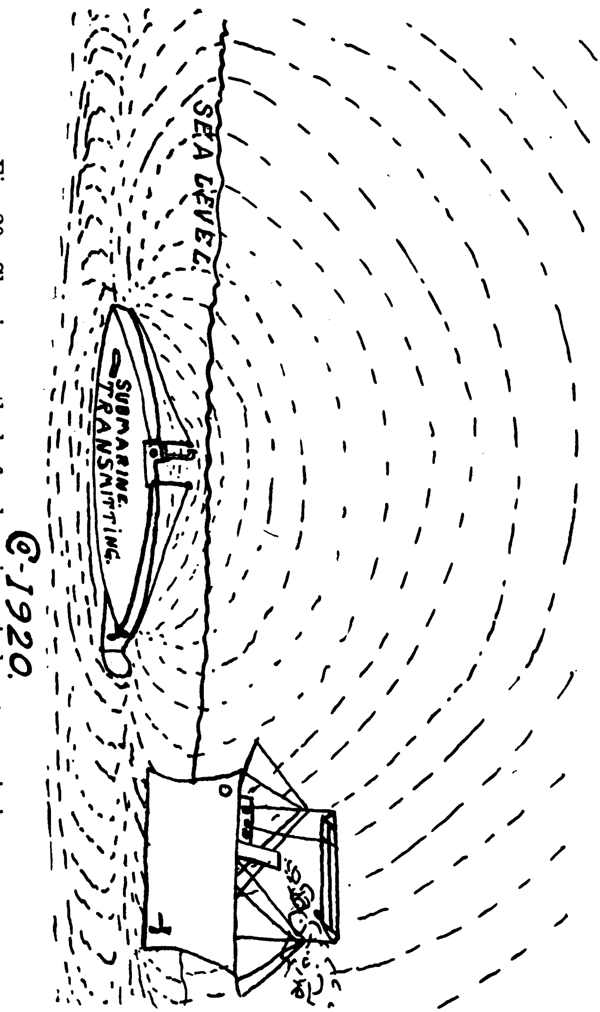

Fig. 20—Showing method of submarine wireless transmission.

as indicated by dotted lines of force. This permits a submarine submerged to communicate with another submerged submarine, a ship on the surface of the sea, or with an airplane flying in the air. When the closed loop antennae is used for receiving wireless only, then the principle involved is conduction.

I can see no difference between the loop antennae as now used on submarines, and the antennae as used by Mr. S. F. B. Morse in 1842. They are both grounded loops and conduction is certainly the principle of transmission in both. The only difference between the two is in the form and nature of current used. Both the Morse and Rogers closed loop antennae operate by conduction in the natural media.

40—Shunting Currents of High Pressures and Frequencies. To those that believe if the air was a good conductor of electricity, the air between the antennae and ground would short circuit or shunt the current, and no current could travel in the adjacent air, I refer them to Fig. 21. Here is shown a OO copper wire shunting the terminals of an oscillation transformer. But does this large wire shunt the currents. My answer is no. This wire has a low voltage resistance of only about .0007 of an ohm, yet the vacuum tube which is shunted across the copper wire as shown is lighted to full brilliancy, by conduction. The low voltage resistance of this tube is many millions of ohms. Six inches of this wire is shunted by a 10 volt 5 watt lamp. It also is lighted to full candle power. If a direct current of low voltage was used to light this lamp in the same manner, it would take about 257,069 amperes in the OO copper wire. This of course could never be reached as the wire would fuse first. If this OO copper wire having a length of only about 10 feet cannot shunt the high potential current, how then could the air shunt all the high potential current from an antennae? There is a great difference in the laws

governing low and high voltage currents. And for this reason, as I pointed out in Art. 17, tables are needed to show the relative resistance of different elements at many high voltages and temperatures. Also tables are needed showing the relative resistance of various elements at many different frequencies. My explanation of this little understood phenomenon is that there is very little difference between the resistance of the OO copper wire, the lamp and vacuum tube to the passage of high pressure and high frequency currents. I would guess at the ratios of resistance something like this:—Ten feet No. OO wire five-billionth ohm, incandescent lamp four-billionth

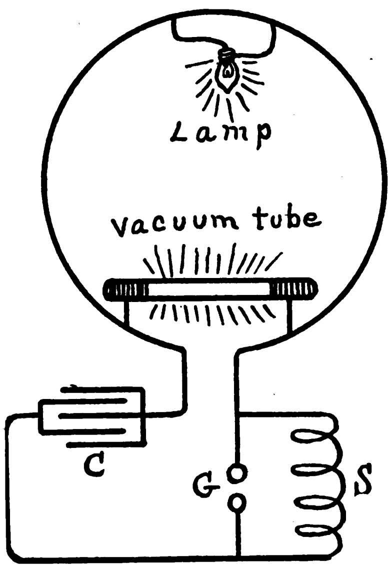

Fig. 21—Showing one law of electricity at high pressure

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ohm and the vacuum tube one billionth ohm. I also refer you to Art. 22. Here the earth is used as a partial shunt for the low voltage currents, but the high conductivity of the earth cannot completely shunt the low voltage currents used in this wireless conduction system. Further I would like to refer those who believe the closed loop antennae as used on submarines would completely shunt the current, if conduction was the cause of transmission, to carefully read this article and study Fig. 21. My reference for a part of this article was taken from "Electricity at High Pressures and Frequencies", by Henry L. Transtrom. For a better explanation of this experiment I refer the reader to the above book. Of course in the lighting of the incandescent lamp and vacuum tube, electro-static stress plays an important part. This phenomenon is very little understood at present, see Art. 12.

41—Static. Static is known as atmospheric electricity, which is caused in many ways, such as lightning, friction, heat, light, and in many other ways. This is of the same nature as wireless as evidenced by operating electro-static detectors in a manner similar to wireless, electric waves. This greatly interferes with the operation of all wireless detectors, and sometimes the static is so much stronger than the signal that the message is drowned out. When a lightning discharge takes place in the form of a visible flash from the ground to the cloud or vica-versa, this makes a conductor of small resistance, but it is impossible for all the current to travel in this temporary conductor; the rest will go by invisible conduction to the ground through the adjacent air. But this is doubtless only one side of the circuit, the other side being by invisible or visible conduction in any part of the world. The rarefied air seems to be the seat of the greatest electrical potential. When the thickness of a cloud becomes great enough it tends to short-

circuit this enormous potential of the rarefied air, and a thunder storm is generally the result. Large volumes of heated air rapidly rising up to the rarer air, sometimes causes the flashes of lightning to appear almost before the clouds do. It has been noted that lightning flashes have been seen from a clear sky, the sudden raising of heated currents of air could be the cause. I have noted that when several flashes of lightning occur through thin looking clouds, nearly every time a heavy rainstorm seems to be generated. It seems that sharp flashes of lightning are the direct or indirect cause in many instances of heavy rainstorms.

In the summer time when the air is heated it is a much better conductor than in the winter when the air is cold. So when we have a cloud of relative small area and a vertical thickness of two to four miles, a path of relative small resistance is provided for the high potential of the rarefied air. As in thunder storms the lower clouds are only about a mile high. The conduction may take place from the cloud to the ground also by invisible conduction. When a storm cloud is overhead strong invisible conduction takes place all the time, thus the air is greatly ionzed and a much better conductor for electricity. The much higher resistance offered by cold air in the winter time is undoubtedly the reason that thunder storms do not occur, as the resistance of cold air is enormous. So a single flash may affect every wireless station in the world by invisible conduction. I have talked with people who have watched a storm from a mountain top and they said the flash seemed to go as high up in the air as it went below the cloud. Even in clear weather there is a constant leakage of the high potential of the upper layers of rarefied air. This sounds in the telephone receivers as a hissing noise, also as sharp clicks. The sharp clicks are certainly from a visible flash of lightning somewhere in the world. The

hissing is the natural leakage through the air of static electricity. In the day time the rays of light from the sun seem to neutralize a part of the static currents. Also the air is a better conductor after night as more moisture is present, these two causes are doubtless the reason that static is stronger after night. In the summer time the air is a better conductor and static is louder as a rule, because the thunder storms are closer. The thunder storms being the seat of greatest electrical static disturbance. The circuit composed of the rarefied air and ground carry the static currents of a lightning discharge all over the world just the same as the law governing a high power wireless transmitter. In both cases invisible conduction takes place between the rarefied air and the ground all over the World. The present theory of static is that it is electro-magnetic waves the same as wireless. And that these static currents are induced in the antennae by electro-magnetic induction. But this seems to me against the elementary laws of electricity.

42—Some Electrical Arguments in Favor of the Conductivity of the Air. To those that still believe in the electro-magnetic theory I would like to ask a few questions.:—

1—Why is the specific inductive capacity of the air three times stronger over the ocean than over the land?

2—Why is the inductive capacity of the air about three times stronger after night than in the day time?

3—Why does a storm affect the inductive capacity of the air?

4—Why does the loop antennae respond stronger when one side is turned towards the transmitting station than the other side?

5—Why does grounding a loop antennae make the signals louder?

6—Why is a pure under ground antennae more efficient than a pure air antennae?

7—If electro-magnetic waves are sent out from an airplane to another airplane why is not a closed antennae system more efficient than one of an open circuit?

8—Why does an inverted L antennae cut more lines of force in one direction than the other, when in the same plane as the transmitting station?

9—If electro-magnetic induction causes the currents in the antennae why won't this induction act through a diamagnetic conductor?

10—If the air is not a conductor why is it so hard to insulate static electricity?

11—If the air is not a conductor of static electricity why is it so easy to discharge static electricity to the ground through the air by points and flame?

12—In wire wireless do the magnetic waves travel the diamagnetic metallic circuit?

13—In wire wireless give a reason why the use of iron wires is not practical?

14—During a certain time this year (1919) the air possessed unusual conductivity, the wireless signals were much stronger than usual. Apply the electro-magnetic theory to this phenomenon.

15—Why is bare wire better than insulated for an antennae?

CHAPTER 4.

Damped and Undamped Transmitting Systems

43—Electrical Oscillations. It was discovered that when a Leyden jar or condenser was discharged it was not a single spark as it looked to be by the naked eye. But by the rotating mirror it was proved to be several score of rapid oscillations flowing back and forth across the spark gap. All of these oscillations take place in a small fraction of a second. Each oscillation becomes weaker, until the potential is no longer sufficient to bridge the gap, and they die out. These oscillations are very necessary for the successful operation of wireless apparatus. For if only one oscillation was made which would last, in a 200 meter wave, only about 1-1.500.000. of a second, this would not be long enough time to cause the efficient operation of detectors. But by several score of oscillations being induced in the aerial by one pulsating current in the primary winding of the transformer, much more

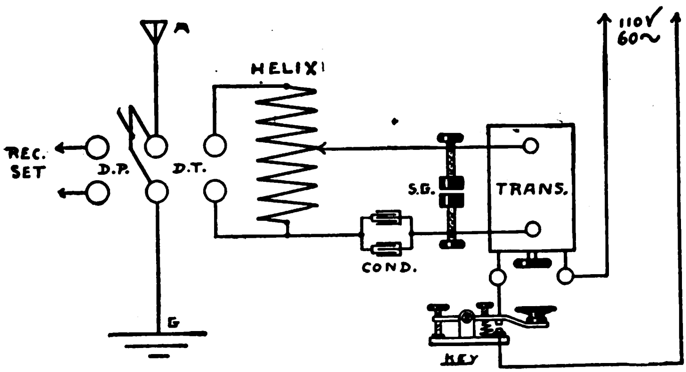


Fig. 22—Modern damped wave transmitting system.

energy is radiated and detectors have more time to respond. Generally those frequencies under 10.000 per second are termed audio-frequencies and those above 10.000 per second are termed radio-frequencies.

44—Damped Waves. The oscillations induced in the condenser and spark gap, by a transformer operating on a low frequency primary current, rapidly die out between each frequency of the primary current, and are therefore known better as damped waves. In Fig. 22 is a drawing of a modern damped wave system.

45—Undamped Waves. When the oscillations induced in the aerial are of a constant amplitude as illustrated in Fig. 23 they are termed undamped waves, because they do not die out into audio frequency

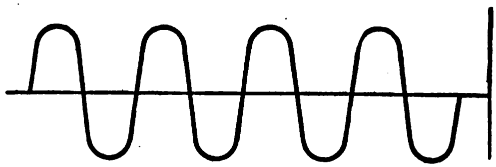


Fig. 23—Wave of constant amplitude.

groups. But they are of a constant amplitude as long as the key is depressed. These waves are ideal for wireless telegraphy and telephony. One reason of their higher efficiency over damped waves is that, when they are broken up into audio-frequency groups the groups of oscillations are of a constant amplitude during their length, whereby in damped waves the audio groups of oscillations rapidly decrease in strength. Therefore the strength of the groups of undamped waves are the greatest, for they tend to operate a detector as strong at the ending as they do at the beginning. There are several ways to produce undamped waves. But the most widely used methods are by the voltaic arc, vacuum tubes and high frequency generators.

46—Arc Methods of Producing Waves of Constant Amplitude. It has been known for many years that the arc produced an opposing electromotive force of its own when burning. This is certainly caused by self-induction. In Fig. 24 is shown an arc undamped wave system. The principle of the operation of the arc seems to be that the self induced currents of high potential, which flow through the

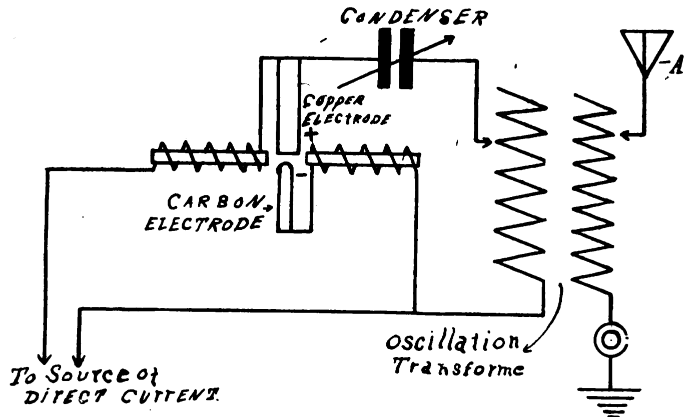


Fig. 24—Arc undamped wave transmitting system.

condenser circuit, by electro-static repulsion change the resistance of the arc, this in turn cuts off part of the direct current, but only lasts a fraction of a second when the original low resistance of the arc is restored but as soon as this happens, an induced current in the opposite direction causes the same operation over again. Thus strong electro-static currents of an alternating nature are induced in the antennae circuit. The frequency of these can be controlled by varying the resistance of the condenser and the self inductance of the high potential circuit. The arc will operate better in hydrogen gas than air because

hydrogen gas is a better conductor of electricity than air. It also seems to be more sensitive to the laws of electro-static repulsions and stress. The principle of operation of the vacuum valve for the production of undamped waves is similar to the arc. In the vacuum tube the variable conducting medium is a heated vacuum, of which the resistance is changed by the self induction of the battery current by the tickler coil, the frequency of the oscillations generated by the tube can also be changed by inductance and resistance in the circuits. The frequencies of the arc are generally from 100,000 to 1,000,000 per second. The vacuum valve can be adjusted so that audible and radio frequencies are produced.

I might also mention here that the principle of operation of electro-lytic detectors, electro-lytic interrupters, the telephone howler, the arc, the vacuum tube, are all very similar, the laws of electro-static attraction and repulsion being the dominating factor, except the telephone howler. The telephone howler being caused mainly by self magnetic induction, which vibrates the transmitter diaphram. The oscillations of constant amplitude produced by the arc, vacuum tube and high frequency generator, are used to a great extent for wireless telephony. When these are used for wireless telephony some form of a voice modulator is used in the antennáe or primary circuits. A close analogy of the principle of the arc is the induction coil vibrator with its high potential condenser. This might be termed a small arc for producing damped waves. All spark gaps and arcs seem to generate both induction and convection currents.

47—Audio-frequency Telephone System. In 1905 I carried out many experiments with the audio-frequency telephone system. In Fig. 25 is illustrated one embodiment of this system. A plurality of micro-

phone transmitters 1 are connected to the primary windings of the transformer 2, the secondary of this

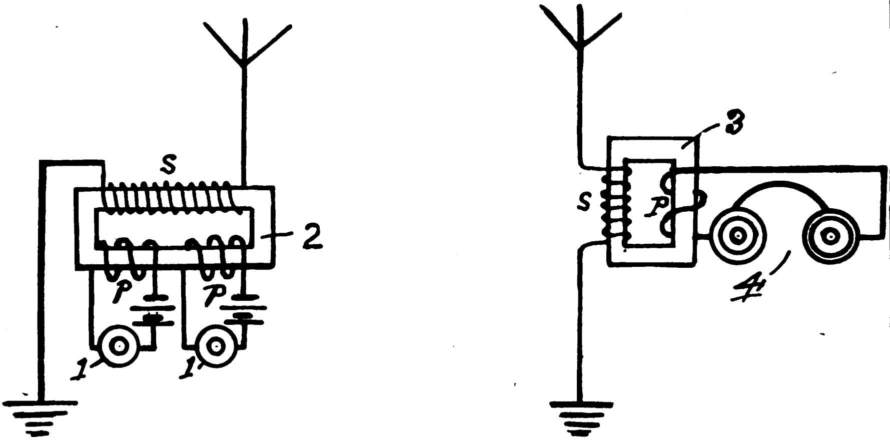


Fig. 25—Audio frequency wireless telephone system.

coil being connected direct to the antennae and ground, no spark gap is used. This constitutes the wireless telephone transmitting apparatus. The method shown for receiving is a step down transformer 3 is employed, the secondary of this winding being connected to the antennae and ground, and the primary winding of this transformer being connected in series with a pair of telephone receivers 4. In practice the secondary winding of transformer 2 should be wound with 36 to 50 B and S gauge electrolytic wire, so that the induced currents in the secondary are of a static nature. The secondary of the receiving transformer should have the same resistance and be wound with the same size wire as the transmitting transformer, preferably of sizes between 40 and 50 B and S. gauge copper wire. The primary winding of transformer 3 should be of the same resistance as the telephone receivers used in series. The primaries of the transmitting receivers

have about the same resistance as the microphones used. The core of the transmitting coil is preferably soft iron but the core of the receiving coil is preferably air, soft iron or nickel, as nickel is five times more susceptable to weak magnetic circuits than iron. In lieu of the receiving transformers the receivers may be connected direct in the aerial. Or if the voltage sent out is high enough the antennae may be connected direct to the grid of an audion tube. If the voltage received is too low for the maxium efficiency of the tube, then step up transformer may be used. With powers and apparatus in use now this system can be used to talk half way around the world. The principle of operation of this system is conduction. (The present theory being electro-static induction.) How many believe that an electro-static field can be created by an open circuit that will reach around the world? If the air is not a conductor of electricity then the vertical aerial is an open circuit. The ordinary spark coils can be used for this audio-frequency system, but they are not as efficient as one wound as above stated. The X-ray coils are the best to use as a transmitting coil.

One induction coil or transformer can be used both for a transmitting coil and as a receiving coil. This can be done in two ways; one way is to have primary windings for the batteries, a secondary coil and another coil for connecting serially with the telephone receiver, all wound around a single core. The resistance of primary battery winding should be about the same as the resistance of the microphone used. The resistance of the secondary winding should be high enough that would step up the current to a high potential so it will travel easy the natural media. The telephone receiver coil should have about the same resistance as the telephone receivers used, and a switch in series so that the telephone receiver can be cut out of circuit when the transformer is being used

for transmitting. Also switches can be used to connect both the telephone receiver coil and secondary coil in series when transmitting, then the telephone receiver coil can also be used in transmitting. Also a switch should be used in the battery circuit, so this circuit can also be opened when receiving. Another way is to use, two, double pole, single throw switches arranged so either the telephone receiver or batteries and microphone can be connected serially in the primary of an induction coil or transformer. This can also be used with one or more primary windings, by using switches to connect the plurality of primary windings in series when receiving. The telephone receiver should have the same electrical resistance as the primary winding or windings. There are many ways in which this system can be embodied, it would take a large book to describe this system alone. In receiving wireless currents of a static nature, an open core may give better results, for a metal core would tend to cut out electro-static induction. But the ratio of winding should be about the same as described above. (See Art. 24.)

48.—Damped Waves By the Buzzer. Probably the most simple method there is for transmitting electrical oscillations is by the buzzer. Here the direct current used is of a very low voltage. As in a battery buzzer the voltage is about one and one-half volts. But the self induction of the little coils contained in the buzzer, and the spark gap, jump up a part of this low voltage current to many thousands of volts. This can be considered a small arc, operating at audio-frequencies. The frequencies here depend upon the mechanical movement of a solid and of course cannot vibrate as fast as if a gas were used instead as in an arc. It matters not how low a voltage we use a small amount of static is present as an electroscope will show, from a single battery. But as the voltage is raised the static electricity present is also

raised. The induced oscillating currents of a buzzer have such a potential that the air becomes a good conductor. Buzzers have been used to transmit 100 miles where large currents were used. The small battery buzzer being used mostly for instruction and testing crystal detectors. The self-induction of a buzzer, can jump up a part of the current to 100,000 volts.

CHAPTER 5.

ANTENNAE, CONDENSERS and OSCILLATION TRANSFORMERS.

49—Antennae or Aerials. As the terms aerials and antennae have the same meaning, I will use them interchangeably throughout this book. For air and ground aerials I refer the reader to other wireless books now on the market. But I will briefly describe a few ground aerials which I have not yet seen published. My experiments with ground aerials commenced in 1914. I used many different types and forms. When a state of war was declared to exist with Germany, I was carrying out many experiments with ground aerials and in many other directions in radio. But the ban on wireless quickly put a stop to my wireless experiments. Several of the ground aerials I experimented with prior to the war have also been discovered independently by others. But in Fig. 26, I show some ground aerials that no doubt will be of interest to amateurs and others interested in the art. I have not enough space to disclose all of my ground aerial systems which have not yet been published. None of these aerials need to be buried as with the Rogers system. But burying them will increase their efficiency in some cases, where lead cable is not to be had. Now I refer you to Fig. 26, a and b, this represents a common lead covered telephone cable having one conductor of copper wire and insulated from the lead covering by rubber. The lead covering of the cable is grounded at both ends down to moist earth. The insulated copper wire is then connected to wireless apparatus as usual, and then to the ground or to a similar aerial, disposed in the same or a different plane.

If disposed in a single plane the aerial is sharply directive. If disposed in different planes then the aerial is not directive. This gives all the advantages of a buried aerial in the ground, and it is easily and quickly placed or moved from one place to another. Fig. 26, b, is the same except some part of the cable is coiled up so as to receive longer wave lengths when the space is limited as in the cities or towns. Fig. 26, c, shows a ground antennae using two coils of insulated copper wire of 14 or other gauge, one end of each of these coils is connected to a wireless receiving apparatus.

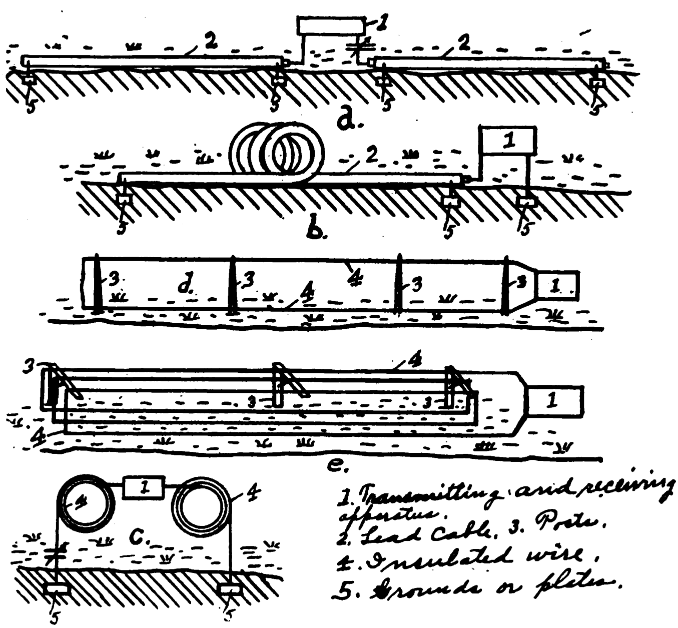


Fig. 26—A few forms of ground antennae.

The other ends of these coils are connected through a condenser to the ground. These grounds can be from 4 to 60 feet apart and the length of the copper wire in the coils may be from 50 to 500 feet long. If litz wire is used in place of a single conductor in any of these aerials the efficiency is increased. This type of aerial is designed mainly for use where space is limited. It does not seem as efficient as when a long wire is used on the ground. But long wave lengths can be received on it. In Fig. 26, d, I show another form of aerial. I stated in previous articles that the main energy of wireless currents traveled through the rarefied air and the ground. If 1 K. W. of current is sent into the ground from an aerial, the same amount is sent into the air, it can't be otherwise. And for this energy to complete the circuit it must travel through the air and the ground. Now as the ground is a much better conductor of electricity than the air, and according to the laws of high frequency currents, practically all of the energy in the ground travels near the surface. The law seems to be, when high frequency currents travel by conduction, insulators at a low voltage, the current spreads out equally in all directions by the laws of conduction. So there is traveling in a few vertical feet of ground the same energy that travels in several vertical miles of air. The insulated loop aerial as I show in Fig. 26, d, receive oscillating currents traveling in the ground, conduction currents can also travel in this form of aerial from the air, as this form of aerial makes a good ground for an aerial. One side of this loop may rest right on the ground the other side 10 or 15 feet high. It may be used in lengths from 50 to 2000 feet depending on the wave length to be received. Also the ground side of this loop may be lead telephone cable, the covering being grounded as shown in Fig. 26, a, and b. The insulated wire being connected to the return loop up in the air. This lower side of the loop could also be

buried in the ground, the return wire disposed above the ground and of course the copper wire being well insulated throughout its length. One or both sides of this insulated wire be disposed in a lead covering. In Fig. 25, e, a plurality of similar coils as shown in Fig. 26, d, are disposed so as to increase the wave length in a limited space. This coil can be anywhere from 2 feet long to 3000 feet, depending upon the wave length to be received and the number of coil turns in the loop aerial. In all of these aerials shown No. 14 copper insulated electric light wire will give good results. But of course insulated litz wire would be better. In Fig. 26, conduction here is the dominating factor. Where there are so many amateurs using the 200 meter wave length it will become a necessity that directive aerials be used. So I give all amateurs the right to use these ground and air aerials, and I hope they will make speedy use of them. I have patents pending on these. If three of these ground aerials are disposed so they will point from the wireless receiving apparatus, in angles of 45 degrees, they will respond from all directions. Selective switches may be used for any or all directions. In all these ground aerials static seems to be greatly eliminated, except those loud clicks, which no doubt are visible flashes of lightning somewhere in the world. Loop aerials d and e can also be used for transmitting wireless messages, to a certain extent. Where a long single loop is used the messages transmitted should be sharply directive. Loop aerials d and e can be bare wire for receiving.

50—Air and Ground Antennae. Before the war I used a form of both ground and air aerial as shown in Fig. 27. I put up an air aerial 1, in a north and south direction about 20 feet high, the lead in wire connected to transformer 2, then through switch 5 to the east end of my ground aerial 7. This ground

aerial was about 300 feet long. The switch 5 was arranged so I could either connect the air aerial to the insulated wire in the lead cable or to the lead covering itself. The signals seemed to be the strongest when connection was made to the lead covering. Also the opposite end of the lead cable could have copper wires extending at right angles buried in the ground so as to intercept more of the advancing wave. I believe this form of aerial is the most efficient that can be devised where an air aerial is used in combination. The air aerial I used was a little over 100 feet long and consisted of 4 copper wires. With this I could hear Arlington at night several feet from the phones, and in the day time I could hear plainly the time with fair regularity with no stopping condenser. I must be 1100 miles from Arlington, W. Va. Since the war I put up my air areial in the opposite direction and 40 feet high, I can not hear Arlington one-half as distinctly with a stopping condenser as I could before the war. I used galena detectors in both instances. This type

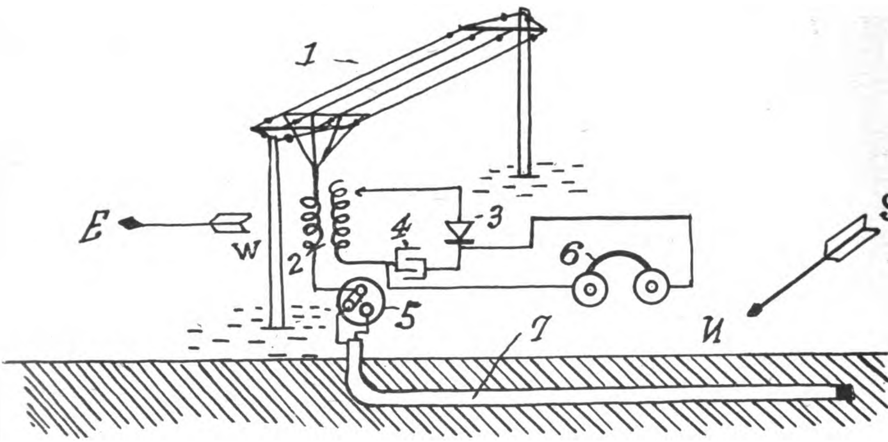


Fig. 27—Summers' Air and Ground Antennae.

of aerial is non-directive, although it seems to receive much stronger in the direction that the lead cable points. This form of antennae is excellent to receive undamped waves on.

51—Miscellaneous Antennae. Most any objects that extend up in the air can be used to a certain extent for receiving wireless as well as transmitting, such as trees, buildings, etc. If a nail is driven in a tree or frame building, wireless can be received quite a distance. Also if the primary of the tuner is connected by shunt across the binding posts on a common telephone in use, messages can be received, if a condenser is connected in series with the primary, the operation of the telephone will not be interfered with, but talking and ringing on the telephone line can be heard in the telephone receiver if an audion is used as a detector, especially on the long wave lengths; on short wave lengths it does not bother much. It matters not whether the telephone that the primary winding is connected to is on a metallic, common or grounded circuit. I have received strong signals when the telephone was grounded through the ringer coils, using an audion as a detector. Also if the line side is connected to the grid of an audion and the ground to the filament, telephone conversations can be heard on many other lines that go into the exchange. This method can be used for detective work, also if an antennae is close to telephone lines, and the grid connected direct to the antennae, telephone conversations can be tapped.

52—Leyden Jar. In Fig. 28 is shown a Leyden jar. This was the first form of condenser used. It is also used at present for many different things. One action of condensers is to hold upon its plates opposite signs of static electricity. After a Leyden jar is charged it can be discharged by discharging tongs. I will not describe here the different methods of charging a Leyden jar or condenser; this can be found in nearly all

of the wireless books. But I will try to describe the theoretical action of condensers. (See Art's 7 and 12.)

A highly insulated Leyden jar or condenser cannot be charged effectively. In order to charge a condenser there must be an electric circuit. If the outer coating of a Leyden jar be connected electrically to the earth and then if an uninsulated person touch the inner coating the jar will be discharged. If the charged jar is placed upon a sheet of vulcanite, we may touch either coating (one at a time) without fear of a shock or discharging the jar. A condenser cannot be charged or discharged without an electric circuit. One plate of a condenser seems to be overcharged and the other plate undercharged. The lesser attracting the greater when the circuit is completed. But as soon as the lesser attracts the greater, then the lesser becomes greater and there is almost as much attraction in the opposite direction or vica versa. The result being an oscillating current. A current of electricity is simply an attractive force acting through a conductor, practically the same as the attractive force of gravitation and magnetism. (See Articles 125 and 126.)

Fig. 28—Leyden Jar.

53—Condensers. In Fig. 29 is illustrated a modern variable condenser. Condensers in wireless telegraphy are generally spoken of and described as means to store electro-static currents, and then to discharge same in electro-static oscillations. But I believe in nearly all of the uses in wireless and similar purposes condensers act as strainers, shunt, fixed and variable resistances for electrical currents. Condensers will hold a charge of static electricity up to a certain amount and potential, but when this is passed all the added energy goes through the condenser by invisible conduction. If the potential of this energy be raised high enough then visible conduction will take place through the condenser dielectric. But it is a law, especially in dielectrics at a low voltage, that invisible conduction will take place at much lower po-

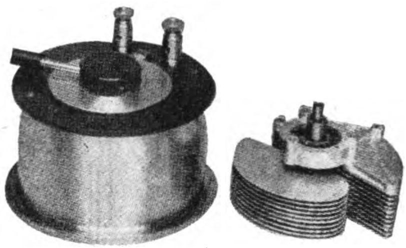


Fig. 29—Modern Variable Condenser.

tentials than are required for visible conduction. A close analogy of this is a storm cloud overhead. It is also a law in conduction, that the resistance of an element decreases as the area of electrodes exposed to same increase. In a condenser a large area of electrodes are exposed to a dielectric at lower voltages, the result is that conduction takes place through a dielectric of low voltage. In Fig, 29 is shown a condenser connected serially in the secondary circuit of the transformer, also connected in series with the condenser, is the primary inductance of the oscillation transformer

and spark gap. It is supposed at present that the current does not go through the serially connected condenser. But this seems to me an impossibility. One proof of the conduction of a condenser is that if not large enough area of the glass is exposed to the metal electrodes, a brush discharge takes place, indicating resistance of the glass. If the area of glass and plate are increased the brush discharge disappears. When a current of electricity is forced through a condenser or high resistance it seems to raise its potential. Now if the area of the glass be increased after the brush discharge has stopped the resistance of the condenser will be greatly lowered, and will not step up the current from the transformer high enough for static oscillations. The spark gap, condenser, and primary of the oscillation transformer seem to greatly increase the potential of the current from the transformer. The potential of the secondary of one to two K. W. transformers is from about 10,000 to 20,000 volts. But in order to radiate this energy from the aerial it must be stepped up to 50,000 or 150,000 volts. In this respect a close analogy of the spark gap is the arc as a generator of radio oscillations. So I believe that future research will prove that many kilo-watts of energy go through by conduction, the dielectric of a condenser. If a spark breaks down the glass dielectric by arcing across then the resistance is greatly lowered, and the condenser will not set up such strong radio oscillations. It then would be simply a spark gap. I refer the reader to articles 7 and 12, in which I have pointed out how the dielectric of a condenser, conducts and generates radio oscillations. Currents that can travel through the glass dielectric of a condenser should be able to travel by conduction, the air which is considered a poor dielectric when compared with glass, also the aerial presents an electrode of large area to the air. (See Chapters on Light and Miscellaneous Ideas.)

54—Stopping Condenser. If a stopping condenser is used, connected serially in the secondary circuit of the receiving transformer, with a crystal detector, and the telephone receivers shunted across the stopping condenser, the condenser acts similar to a valve; it allows the high voltage oscillating current to shunt through the condenser, but holds back the lower voltage current generated by the crystal detector. Or in other words the stopping condenser acts as a strainer for electricity by allowing the high voltage oscillating current received from the aerial to go through easily, and at the same time holding back practically all of the direct current generated or altered by the detector, and causing the latter current to go mainly through the telephone receivers. A close analogy of this is the condenser used for magneto line telephony, the condenser here allows the high voltage alternating current generated by the induction coil, which is voice currents, to pass through easily, but the low voltage alternating current generated by the magneto generator for calling purposes, is held back and caused to go mainly through the ringer coils. The condenser in the telephone being used so that when the telephone receiver is off the hook, if anybody tries to ring any one, a large part of the current will not shunt through the secondary of the induction coil, thus decreasing the signalling efficiency. The resistance of the condenser being greater than the resistance of the ringer coils, not very much of the alternating current generated by the magneto generator can pass through. A condenser can thus be used as resistance in a circuit. Another analogy of the stopping condenser is the condenser used, connected by shunt, across arc and spark gaps.

55—Condensers as Shunt. Generally in this article I will explain the condenser acting as a shunt for wire and wireless circuits. This principle applies to submarine cables, line telephony and aerials. All three of these can be considered condensers. A sub-

marine cable is considered a condenser of enormous capacity, the dielectric that separates the conducting elements, acts as a shunt for electricity, tending to short circuit the current sent into the cable. When an electrode is exposed to a dielectric at a low voltage, for thousands of miles, the conductivity of the supposed dielectric becomes a great hindrance to the flow of electricity. The dielectric of a submarine cable acts as a slow ground for the current, the conductivity being in proportion to the voltage used. This is certainly the reason that high voltages can not be used in Trans-Atlantic cables, as the large area of dielectric exposed becomes an excellent conductor and none of the currents can reach the other side. This is doubtless the reason the Atlantic cable would not work at first when a large number of batteries were used, when some one suggested to use only a few batteries then some of the current reached the other side. So much of the dielectric being exposed makes it a good conductor for even low voltage currents. I believe the best dielectric is preferably the substances having a low inductive capacity which is mainly used now as the dielectric in Trans-Atlantic cables. In other words the best insulator, cost considered, should be used as the insulation for submarine cables. I also believe some means will be used whereby telephone communication can be carried on through Trans-Atlantic cables. If this is ever accomplished the telephone transmitter doubtless will have to be connected serially in the cable circuit and very low voltage currents used. A plurality of microphones might be connected in multiple. Or other means may be used to modulate the current. At the other end a step-up audio-transformer might be used connected to a cascade of audion amplifiers. If an audio transformer is used with the telephone transmitters, which is the custom now, low voltage currents should be used in the primary winding, the ratio of the windings of the transformer should be one

to one, or step down the current instead of raising it, also the secondary winding should be connected in series with the cable and a low voltage source of direct current, then when the voice modulations of the primary currents were impressed upon the secondary circuit they might reach the other side, and be detected by a step up audio transformer with the secondary connected to a cascade of audion amplifiers. The submarine cables should make an efficient ground antennae for either the transmission or reception of wireless or both. Line telephony is short-circuited in a manner similar to submarine telegraphy. This is the reason that a person can talk only a limited distance on telephone circuits. The air grounds or short-circuits the voice currents. Long transmission lines at a high potential also are governed by the same laws, a part of this is short-circuited by the intervening air or medium. The residual charge of the submarine cable also greatly interferes with sending of messages. (See Art. 57.)

56—One Wire System. It is supposed at present that electricity of a high potential can be made to travel one wire, when one wire is connected to a condenser or capacity. This capacity may be in the form of any low voltage conductor, such as a metal plate, antennae or a person. The other wire from the secondary of the transformer being connected to the

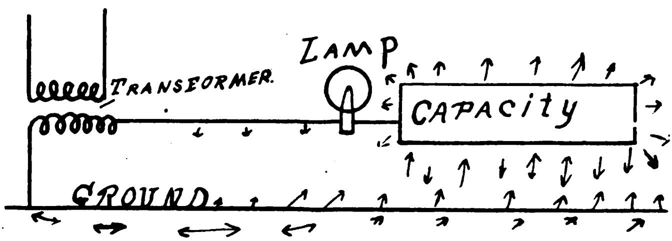


Fig. 30—Tesla One Wire System.

ground or to a capacity as stated above. The air and other supposed dielectrics separating these capacities. See Fig 30. The incandescent lamp shown is supposed at present to be lighted by the inductive action of the plates or capacities. But my experiments prove that the principles involved is conduction between the plates or the person and the ground. As shown by the arrows the air between the capacity and the ground completes the electrical circuit. The capacity or person presents an electrode of large area to the air and both visible and invisible conduction will take place through the air to the ground. So a one wire system is surely a misnomer. In this system there is a complete electrical circuit, as the arrows in the natural Media indicate.

57—Phenomenon of a Condenser. The study of a condenser is very interesting. The conductivity of the medium in which the plates of a condenser is disposed, seem to determine its capacity of holding a charge of static electricity. Of all the elements generally used in a condenser as a dielectric, air seems to be the best conductor for high voltage currents. The laws governing electro-magnetic and electro-static induction are vastly different, because if a piece of sheet brass, which is diamagnetic be disposed between the poles of a permanent magnet, magnetic induction will act through; but if a sheet of brass be placed between a static charged substance and one uncharged, induction will not take place. So this tends to show that the conductivity of the intervening medium plays an important part in electro-static induction. Hence we might have the law; as the conducting medium increases, induction increases, or vica versa. This would also point out that the table of inductivity value as given in Art. 11, can also be used as a table of relative conductivity when that of air is taken as 1.00. (one) at ordinary temperature. If the temperature

of glass be raised so as to be a better conductor, the apparent capacity of the glass is raised, as observed by Cavendish. When a condenser is discharged, a residual charge can be had in a short while. This seems to show that the charge penetrates into the glass. Air condensers exhibit no residual discharge. This apparent soaking in of a dielectric would also apply to a submarine cable.

When a condenser is discharged a sound is often heard. This was noticed by Sir W. Thompson in the case of air condensers. This tends to prove the conductivity of the air, as when a condenser is discharged the increased electrical stress in the dielectric by conduction seems to cause an audible sound, by a sudden change in volume. Close analogy of this is the expansion of the volume of water when a spark from a Leyden jar is directed through it. Siemens has shown that the glass of a Leyden Jar is sensibly warmed after being several times charged and discharged. This would also tend to prove the conductivity of the glass, as heat can be caused by a current flowing through resistance. The electro-static stress set up in glass when a current passed through would also generate heat. The seat of charge resides upon the dielectric as proved by Benjamin Franklin, for when the coatings of the jar were removed, they showed very little signs of electricity but when they were replaced they were strongly charged, showing that the electricity remained in the molecules of the glass jar. An analogy of this would be the plates of a voltaic cell. This would also tend to prove the conducticity of glass. When a condenser is connected in series or in multiple of the secondary circuit of a high potential transformer, the oscillating current going through the glass raises the temperature of the glass, principally by electro-static stress. This further increases the conductivity of the glass. In line telephony the most detrimental factor

is conductivity of the dielectric, as when air is used, no residual charge is present, but if a solid is used as a dielectric, then a residual charge is present also. In submarine telegraphy the most detrimental factors are conduction, induction and residual charge of the dielectric.

58—Oscillation Transformers. The laws of electro-static currents permit of tuning electrostatically, so that a great degree of selectivity is accomplished. For this purpose is used an oscillation transformer or tuner, both for the sending and receiving. In Fig. 31, is illustrated a modern transmitting oscillation trans-

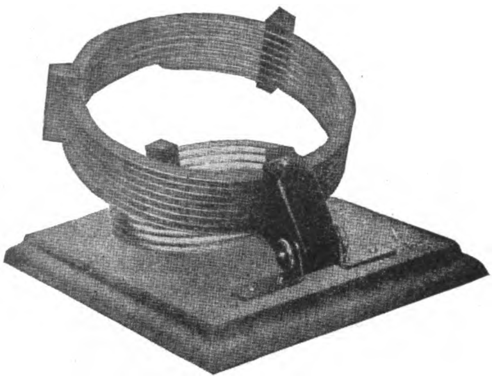


Fig. 31—Oscillation Transformer, or Transmitting Tuner.

former. The mechanical and electrical construction of an oscillation transformer is vastly different from a transformer constructed for low voltage currents. In the former only a few turns of very heavy wire are used in the primary and secondary, in the latter a few turns of heavy wire are used in the primary but in the secondary many miles of fine wire are used. In this latter a magnetic field is the dominating cause of induction. In the former electro-static induction seems to be dom-

inating cause. The electro-static currents in the primary induce, by electro-static induction, static currents in the secondary, the length of these induced currents depends upon the length or capacity of the conductor in the secondary circuit. The static currents in the primary being of a rapid oscillatory nature, similar currents are induced in the secondary which first flow in one direction and then in the other, the rapidity of reversal depending upon the wave length being used. In a two-hundred meter wave the oscillations occur at the rate of about 1,500,000 times per second. This sends out into the air by conduction positive and negative charges in groups of a fixed wave length. If these currents go through a receiving tuning coil as shown in Fig. 32, and the length of the primary is adjusted to correspond with the wave

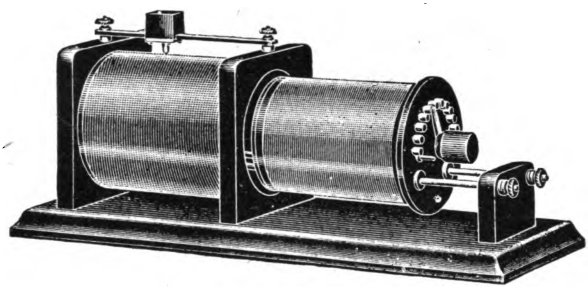


Fig. 32—Oscillation Transformer, or Receiving Tuner.

length, the secondary will then have more current induced in its winding; for if the length of the primary winding to made too short, the maxium electro-static field can not be created around the primary winding; also if the primary winding be adjusted too long, then the static current spreads over more surface and the static field does reach as far out in space and also the two groups of waves at the same instant in the primary circuit tend to polarize one another. It is claimed at

present that the dominating factor of an oscillation transformer is electro-magnetic induction. My experiments and study tend to show that the dominating factor is electro-static induction. This is doubtless the reason that an air core is more efficient in an oscillation transformer than an iron core, for it is a well established law in static electricity that if a metal is disposed between a body charged and a body uncharged, induction will not take place. If a metal is used as a core in oscillation transformers, a conductor is then placed in the electro-static circuit. If electro-static induction is the dominating cause for action of oscillation transformers then a substance having a higher electro-static inductance than air should be used to submerge the transformer. Of the liquids, castor oil should be efficient, and of the solids, glass or selenium should be used. This applys to both transmitting and receiving transformers. When substances are used having a higher co-efficient of inductance than air, the primary and secondary can be brought closer together thus increasing their efficiency. For substances having a higher inductance or dielectric strength than air, see Art. 11. If liquids are used some kind of a container can be employed in which to put the liquid and oscillation transformer. When some solids are used, the coils of wire may be formed and the high inductive solid melted and run around same, forming a solid block. If the transformer is to have an adjustable wave length, taps may be taken to a switch disposed on one side of the block.

I believe cylinders of extra dense flint glass would be more efficient to wind the inductive coils on than specially prepared cardboard as is generally used at present for tuners. In using liquids and solids for the inductance substance in oscillation transformers, the law of residual charge of a dielectric might interfere some with the efficiency.

When electro-static currents strike a metal, they spread out all over the surface in their general direction of travel, either by induction or conduction. The speed of electricity is about 186,000 miles per second. The induced oscillations in a metal, capacity or circuit depends upon its length and capacity. To find the number of oscillations being induced in a circuit, divide the speed of electricity per second by the wave length used; the product will be the oscillations per second. The speed of electrciity in meters is about 300,000,000 meters per second. Below is a table showing the most used wave lengths and the frequency of same.

One Meter equals 39.37043 inches.

Wave length in meters	Frequency or Oscillations per second.
200	1,500.000
300	1,000.000
450	666,666
600	500,000
1000	300,000
2000	150,000
3000	100,000
6000	50,000
8000	37,500
10000	30,000

Below I will add a few wave lengths that are interesting, which are little used at present.

100	3,000,000
50	6,000,000
25	12,000,000
$12\frac{1}{2}$	24,000,000
1	300,000,000
0.0000006 (about)	500.000.000.000.000 (visible light)
20000.	15.000
40000.	7.500
100000	3.000
300000.	1.000
1000000.	300.

In undamped or continuous wave systems of wireless, the last four wave lengths here mentioned, a polarized receiver should respond without a detector, as the frequencies come within the audibility of the human ear. In forègoing table a great contrast is shown between extremely long and short wave lengths.

CHAPTER 6.

ELECTRO-STATIC DETECTORS

59—The Problem. In present wireless systems electro-static oscillations are sent out from the transmitting station. A small portion of these currents is received by an antennae. These oscillations oscillate at far above audibility; in a 100 meter wave 3,000.000 times per second, and are generally sent out in groups of from 60 to 500 per second in the form of dots and dashes representing a code. In Fig. 38 graph 0-1 represents a group of oscillations flowing in both directions at a speed far above audibility. Receivers that are used now are polarized, one cycle or oscillation, which is a current in both directions, will vibrate the diaphram once. But a receiver diaphram can only vibrate up to a certain rate, which is not very far above audibility, even if the receiver diaphram could follow the oscillations of wireless it would not be audible to the human ear, as vibrations of 40,000 times per second is about the limit to which the ear is sensitive. Probably the most sensitive vibrations to the ear is from about 500 to 3000 times per second. So some means must be used so that these damped wave trains or groups of oscillations will vibrate the telephone receiver once, and then if these groups are sent out from the transmitting station at about 1000 times per second, the sound sent out from the diaphram will have a musical pitch. Instruments that cause a polarized receiver diaphram to vibrate once to each group of oscillations are called detectors. Their action seems to either alter or generate a local direct current. There are many different types and classes of detectors. The main ones of interest are Hertz resonater, Summers diaphram detector, coherer, electrolytic, Fessenden

barreter, crystal detector, Flemming two element tube, DeForest three element tube, air audions, gas audions and rarefied air and gas audions.

60—Hertz Resonater. Heinrich Hertz in 1888 carried out some experiments that were of vast importance to science. He proved in an experimental way that wireless and light waves were identical in many respects. However this theory was opposite to that of Prof. Hughs' conduction theory, which he claimed were electro-magnetic waves. The electro-magnetic induction theory was accepted by the scientific men of that day, and is still held as the dominating factor of wireless transmission. But I believe the apparatus that Hertz used was caused by conduction instead of by electro-magnetic induction. I will go through in a brief way the experiments carried out by Hertz. He used an oscillator A connected to the terminals of an induction coil, and the resonater B. Sparks were kept going across the spark gap of the oscillator, then when the resonater was placed in certain positions relative to the oscillator, sparks were observed to pass across the spark gap of the resonater. See Fig. 33. This was obtained when several meters from the oscillator. In explaining this I will use the electro-static conduction, instead of the electro-magnetic induction theory. When the spark gap of the oscillator discharges the secondary of the induction coil, the metal electrodes on each side of the spark gap acts as a condenser, and after each spark, there are a series of induced oscillations going through the spark gap caused by the oscillator, as I have mentioned before that when a condenser was discharged or caused to oscillate, the rest of the circuit was through the dielectric. Under high frequencies insulators at a low voltage become good conductors for electricity. In this case the air is the dielectric, so the lines of conduction from the plates of the oscillator, take the general dir-

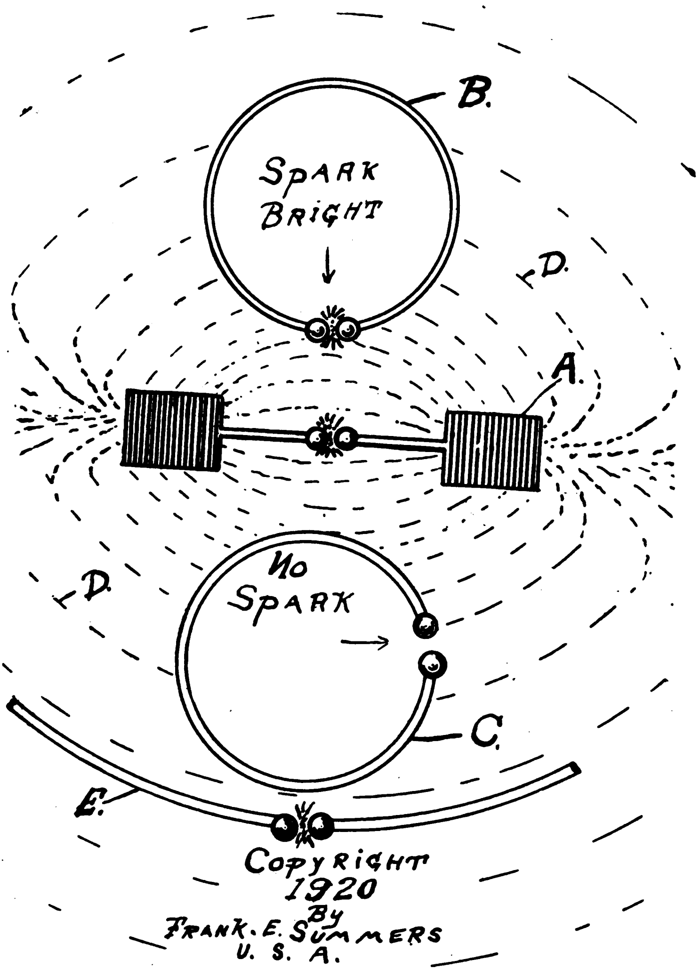


Fig. 33—Hertz Oscillator and Resonater, illustrating the conductivity of the natural media.

ection, to the lines of force from a bar magnet, these lines of conduction are represented by the letter D. Now if we dispose the resonater, vertically at right angles to the lines of conduction or to the spark gap, several feet away from the oscillator, no sparks will pass across the balls of the resonater, whatever the situation of the spark gap in the circle.

If the resonater B is disposed edge on horizontally to the oscillator, as shown in Fig. 33 sparks will pass across the spark gap of the resonater if the gap is parallel to the spark gap of the oscillator and to the lines of conduction D. If the spark gap of the resonater C is disposed at right angles to the spark gap of the oscillator and to lines of conduction D very weak or no sparks are observed, to pass across the gap of the resonater. It seems to me this proves conduction instead of induction. For if induction was the cause of the current in the resonater, just as many lines of force should be cut in the position C as in B. If induction was the cause of this phenomena the spark should be just as bright in both positions of the resonater. Then if two wires are placed parallel to the lines of conduction D with a spark gap near the center as shown at E bright sparks are observed, this seems to again prove conduction.

In Fig. 34 the resonater is turned broadside onto the oscillator, several feet away, the lines of conduction D would appear in parallel lines to the oscillator as shown. Now if the spark gap in the resonater is placed at right angles to the lines of conduction D or to the spark gap of the oscillator, no sparks will pass across the gap of the resonater as shown at C. If the gap in the resonater is turned at the top or bottom as shown at B, bright sparks will go across the gap of the resonater. In the latter case the spark gap of the resonater is again parallel with the lines of conduction D and spark gap of the oscillator. The resonater here used

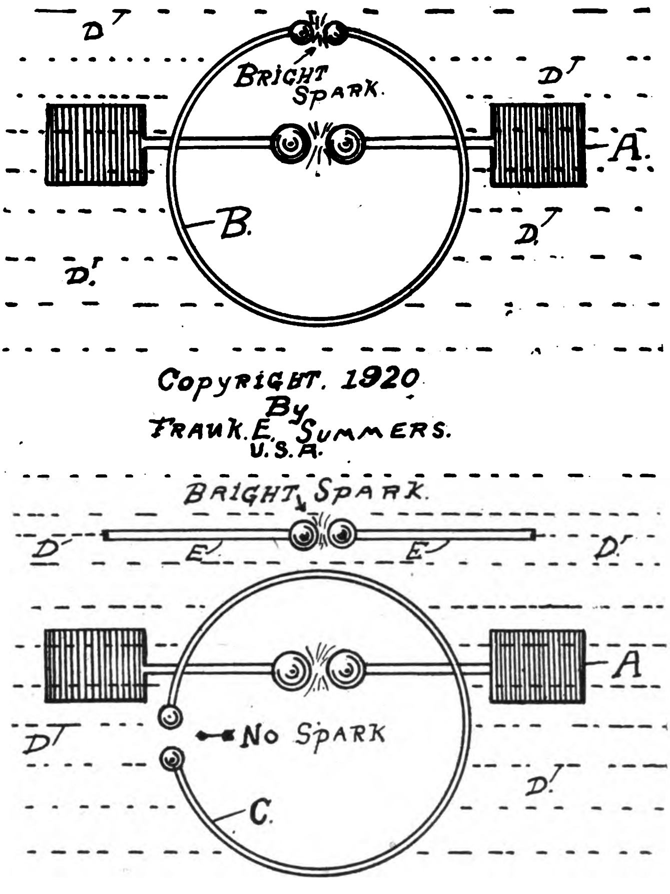


Fig. 34—Hertz Oscillator and Resonater, illustrating the conductivity of the natural media, when resonater is disposed broad side unto the Oscillator.

is about 27 inches in diameter. In Fig. 34 when the spark gap is at the top or bottom there are bright sparks in the gap, but if the gap is at either side no sparks are observed. The experiments of both of these figures seem to prove the conduction of wireless transmission, instead of electro-magnetic induction. The plates or capacities in these experiments used in the oscillator, are hollow zinc cubes. And tuned to the resonater electrically. The wireless electric waves used in this experiment are extremely short, only last about 1-100.000.000 of a second. These high frequency waves can go through all inulators by conduction. In the experiments of the resonater, the side that has the spark gap in offers no more resistance to the passage of the currents than the side of the resonater that is solid. This is a little understood law at present of currents of high pressures and frequencies.

For an analogy of the conductivity of the resonater and this experiment see Art. 40.

In this experiment the resonater being 27 inches in diameter, quite a large area is exposed to the invisible electric currents going through the air and enough currents travels through the coil to make a visible spark.

If a thin sheet of conducting substance be placed between the oscillator and the resonater no sparks will pass across the gap of the latter regardless of its position, this totally stops the wireless waves. This seems another argument in favor of the air acting as a conductor. For induction should take place through a diamagnetic sheet of conducting material.

61—Summers' Diaphram Detector. I have made several experiments that tend to show that the laws of electro-static repulsion, attraction and stress govern all detectors. One of them is illustrated in Fig. 35. Here is shown a regular wireless telephone receiver with the electro and permanent magnets re-

moved, leaving the shell, diaphram and screw cap. A hole is drilled and tapped in the back of the casing to which an iron screw is fitted, having a sharp point which is adjustably mounted in contact with the center of the diaphram, as shown. The wireless circuit is directed through this adjustable contact, which should have a micrometer screw for fine adjustment. When a certain adjustment is reached the electrostatic

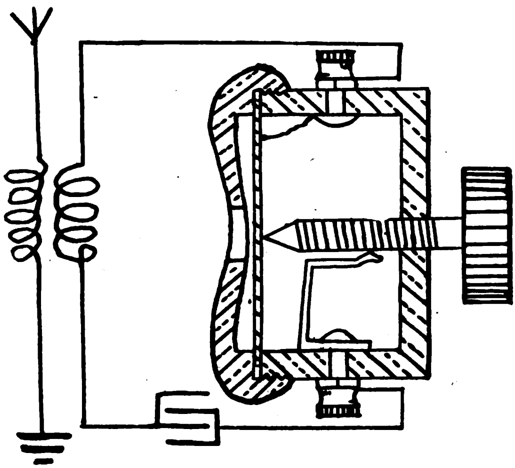


Fig. 35—Summers' Diaphram Detector.

attraction across the loose contact causes the diaphram to vibrate and sound is emitted. The sensibility of this device seems to be about the same as the paramagnetic coherer. By carefully adjusting this device telephone conversations can also be received. A coherer contact for this device instead of the solid point seems to increase its results and does not require such close adjustment. This device is hard to keep in adjustment, but it shows the electro-static power of attraction of oscillating currents. I would like to also

bring out in this article that when electro-static oscillations surge across a loose contact each side is always charged with the opposite kinds of electricity; hence, the attraction or stress.

If two metal balls are disposed in light contact. It matters not whether a direct or an alternating current is going through the loose contact, the balls are always charged with the opposite sign of electricity, hence, the attraction or stress.

62—Properties of Electrical Stress. Here is a field of science that has been little explored, and is full of future possibilities. The stress set up by electro-static oscillating currents in conductors is enormous. By electro-static conductors I include solids, liquids and gases. For instance, pure water is a good insulator for the two volt battery, but a good conductor for static electricity. Also air is a good insulator for a two-volt battery but a good conductor for static electricity. As the voltage and frequencies increase, the resistance of insulators at low voltages decrease. When a high potential oscillating current is directed through an insulator at a low voltage, electrical stress is set up, see Fig. 36, Here the expansion of the water, in the glass tube which is corked up at both ends, shatters the glass in many pieces. This shows that there was a mechanical strain in the water. Electro-static strain is certainly set up in all conductors when electro-static oscillations pass through. In some substances the effect is to expand while in others there is contraction.

Fig. 36—One illustration of the power of electro-static stress.

A wireless detector can certainly be made by using two substances, in adjustable contact, one expanding and the other contracting. See Art. 12. There are several secondary effects of electro-static stress, such as a mechanical strain of molecules and thermal power. A close analogy of the phenomenon illustrated in Fig. 36, is fluid or electro-lytic and crystal detectors. (See Art. 114.)

63—Hot Wire Ammeters. There are at present several means to measure electrical currents; one of them is the hot wire ammeter. When a low voltage direct current is sent through the fine wire in the meter, it is heated and caused to expand, thus affecting the indicating needle which registers in amperes. I have noted that a reliable company is advertising a hot wire ammeter, to register both, low voltage direct currents and high potential high frequency currents, with the same scale of figures on the dial. I do not believe that a hot wire ammeter can register accurately high potential high frequency currents when the scale on the dial has been made for low voltage direct currents. As when the same amperage of oscillating static currents pass through, much greater electrical stress is set up which causes the fine wire to expand much more in proportion. Doubtless the expansion of the fine wire starts before there is any heat present, when weak currents pass through, but if the current is strong enough then as a secondary effect heat is generated which further expands the wire. In measuring electro-static oscillating currents we have as the dominating factors, the electrical resistance of the fine wire, expansion and heat due to electro-static stress. These all add to make a much greater registration of amperes than there should be. I believe hot wire ammeters are deceiving radio-engineers today, which I believe also the near future will prove. For instance, the hot wire ammeters that are being sold to amateurs generally measure

to 5 amperes. This should be large anough for the largest radio stations in the World at present. The voltage or potential generally sent out by high power stations is around 150.000 volts. Now in a 450 K. W. station if the efficiency was 100%, there could not be more than 3 amperes in the antennae circuit. For 150.000 times 3 equals 450.000 watts or 450 K. W. I believe I am safe in saying that not a single high power station in the world transmits one ampere in the antennae circuit.

64—Coherers. The discovery that metal powders could be made to cohere when electro-static oscillations passed through them, resulted in the coherer shown in Fig. 37 which includes a base 1, having mounted thereon binding posts 2, adjustable rods

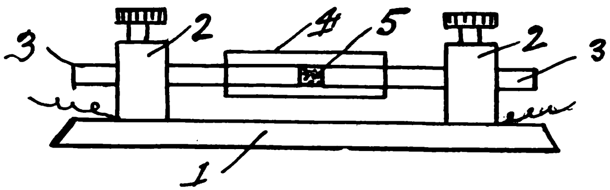


Fig. 37—Para-magnetic, ferro-magnetic or diamagnetic coherer.

3, and glass tube 4. The ends of the rods are disposed inside the glass tube and particles of conducting material 5 are placed between the rods as illustrated. Connected in series with the conducting particles are the aerial circuit and a local battery circuit. Also connected serially in the local battery circuit is a visible or audible device which responds to the signal. Coherers are divided in two different classes, namely—paramagnetic and diamagnetic. A paramagnetic coherer consists of paramagnetic particles in the glass tube. This type was the first invented. When the electro-static oscillations passed through them they

were caused to cohere by electro-static attraction and stress, being in series with a heavy battery circuit, the magnetic effect of the local current caused the magnetic particles to still cling together by electro-magnetic actions after the oscillations has stopped; so some means had to be used to restore them to their original high resistance. This was done mainly by electro-magnetic means which automatically tapped the glass tube when the oscillations were passing through. See articles 28 and 29. If diamagnetic particles, such as carbon, are disposed in the glass tube, then when electro-static currents passed through, the particles cohered together by electro-static attraction and stress, causing the resistance of a local battery circuit to be lowered, which operated a telephone receiver. But after the electro-static currents stopped, the local currents could not magnetize the diamagnetic particles and they returned to their original high resistance. Thus an auto-coherer is the result. Only very short distances can be covered with the para-magnetic coherer, but with the diamagnetic coherer, Marconi used this for trans-oceanic

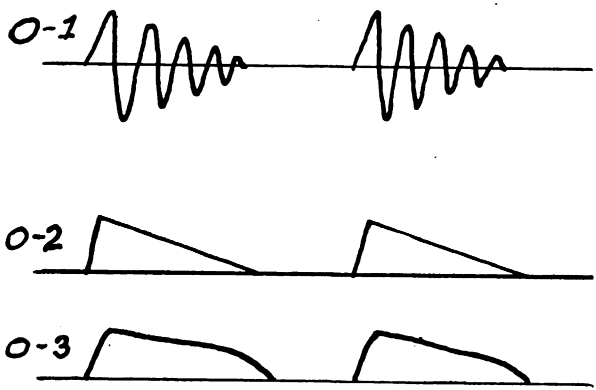


Fig. 38—Graph illustrating the relation of incoming oscillations, altered current and vibration of receiver diaphram.

reception. The relation of the electro-static oscillations and the local current in a diamagnetic coherer is shown in Fig. 38. Here graph O-1 represents the incoming oscillations, graph O-2 the altered local direct current, and graph O-3 the vibration of the receiver diaphram.

By the word para-magnetic in this article is also included metals that are ferro-magnetic.

65—Fessenden Barreter. This type of detector is about as sensitive as the para-magnetic coherer. It is made by sealing a fine platinum wire in a vacuum. When electro-static oscillations are passed through, the resistance is raised by electro-static stress and a local battery current is altered, to correspond with the received signals. A close analogy of this is the hot wire ammeter.

66—Rectifying Action of Detectors. Science claims at present that the type of detectors known as electro-lytic, crystal and vacuum tube, are rectifiers, or valves; that is they will allow the currents to go through in one direction, 400 to 3000 times better than in the other, so the oscillating current is changed from an alternating to practically a direct current: one direction of the current being held back. If the alternating currents can go in one direction 400 times better than in the other direction, there would be a direct current in the telephone receiver only, as the current let through in the other direction would be only 1-400 of the direct current, so it would not be measurable. In Fig. 39 graph O-1 represents the incoming oscillations, these take place at the rate of 1,500,000 times a second in a 200 meter wave and 30,000 times per second in a 10,000 meter wave, see table in Art. 58. Graph O-2 shows the pulsations in one direction, and in a 200 meter wave each pulsation lasts 1-1,500,000th of a second. Graph O-3 shows how the group of direct

pulsations vibrate the diaphram of the telephone receiver once. This applies to receiving damped or undamped waves. If electrolytic or crystal detectors

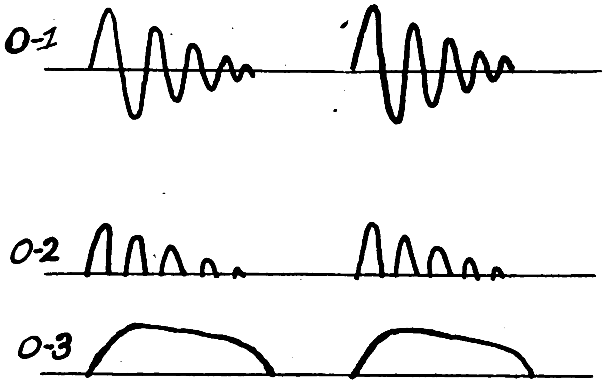


Fig. 39—Graph illustrating the rectifying action of the valve theory.

are rectifiers, then if two detectors were used and arranged as shown in Fig. 40 with their polarities as illustrated and telephone receivers connected serially on both sides, the signals should be twice as loud, as

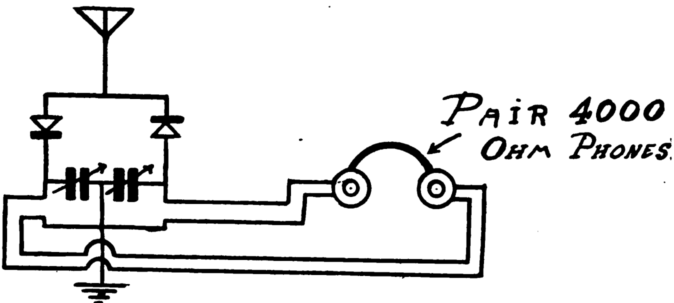


Fig. 40—Experiment with polarities of a detector reversed, so either direction of the incoming oscillation can go through.

the current could only go through a single detector in one direction, there would be in both receivers a direct current, but flowing in opposite directions. This would utilize the electro-magnetic power of both directions. The drawing is self-explanatory.

67—Electrolytic Detector. In Fig. 41 is shown a modern electrolytic detector. It consists of an extremely fine platinum wire mounted in an adjustable

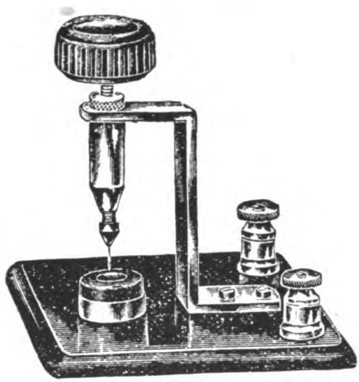


Fig. 41—Modern electrolytic detector.

contact with an electrolytic fluid. A weak battery current and a telephone receiver are connected in series with the detector. The point of the platinum wire must just touch the fluid. It is claimed at present that this detector is a rectifier, by forming small gas bubbles around the platinum point when electro-static oscillations pass through. If this is the case the bubbles must be formed and destroyed 1,500,000 times per second, which seems to me an utter mechanical impossibility. I am inclined to believe that the action of this detector is not shown in Fig. 39 but in Fig. 38. The action seems to be that when a group of oscillations go through the detector, by electro-static attraction

and stress the fluid is drawn higher up on the platinum point, thus decreasing the resistance as long as the oscillations pass through, a local current being altered thereby, and the diaphram of a telephone receiver vibrated. Instead of being a group of pulsating direct currents, corresponding with each group of incoming oscillations, one altered direct pulsation lasts as long as the incoming oscillations, see Fig. 38 graph O-2. If the bubbles could be made to form here at the rate of a million times per second, the electrolytic interrupter could be used as a generator of radio oscillations for wireless telephony. (See Art. 112.)

68—Crystal Detectors. Dr. W. Greenleaf Pickard discovered that if certain crystals were used as a wireless detector no battery was required. In Fig. 42 is illustrated a modern crystal detector, the crystal a, is mounted in a cup on spring c, a fine copper

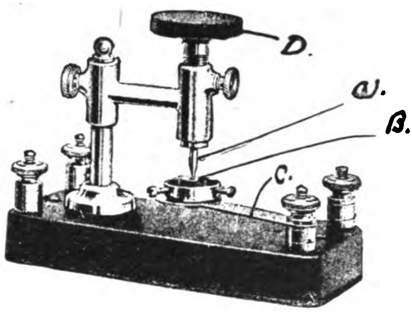


Fig. 42—Modern crystal detector.

steel, brass or bronze point is disposed in adjustable contact with the crystal by thumb nut d. This type of detector can be used without or with a local battery. The crystals most used are galena, silicon, iron pyrites, copper pyrites, zincite, carborundum and radiocite. It was claimed at first that the action of these detectors was caused by the heating of dissimilar metals at a

point of loose contact, thus they were called for a long time thermal detectors. But science claims now that the action of crystal detectors are valves or rectifiers, That is they will only allow the current to travel in one direction, thus only one-half of the magnetic power of the current is utilized. But my experiments and study tend to show that they are generators of a local direct current in the phone receiver circuit by the laws of electro-static attraction, repulsion and stress. If a local battery is used with a crystal detector then a local current is both generated and altered. When electro-static stress is set up in certain crystals a mechanical strain of the molecules is the result. And a direct current of contact and thermo electricity being generated, this causes the vibration of the telephone receivers. The laws of electrostatic attraction and repulsion, cause electro-static stress to be set up in conductors, and secondary effects of this is to cause a mechanical strain of the molecules, and heat. Thus if a crystal detector is used having two dissimilar elements in contact, their polarity can be determined by refering to tables of contact and thermo electricity, which is generally opposite to the same elements in a chemical bath. For instance, take the Perikon detector which is composed of two different crystals in adjustable contact, the crystals being copper pyrites and zincite. Now refer to tables on contact and thermo electricity, articles 14 and 15, the polarity of this detector will be as follows: The copper will be the negative pole and the zinc the positive pole. Now refer to the chemical table of the same elements in a chemical bath operating as a voltaic battery, the zinc will be the negative pole and copper the positive pole. Thus if a battery is used with this detector, copper must be connected to copper and zinc to zinc.

Whether or not the crystal detector, generates a pulsating current for each radio oscillation, or one

pulsation for a single group of oscillations, I would not want to say for a certainty. In the former there would be generated direct pulsations of current at a speed far above audibility, in the latter there would be generated audio-frequency currents, or one pulsation for a group of incoming oscillations. However I believe the later is correct, especially in short wave lengths where the oscillations oscillate at millions of times per second.

I have made several experiments to determine which of above theories were correct, one of them being shown in Fig. 43. F is a receiving transformer connected serially. There in is a crystal detector and pri-

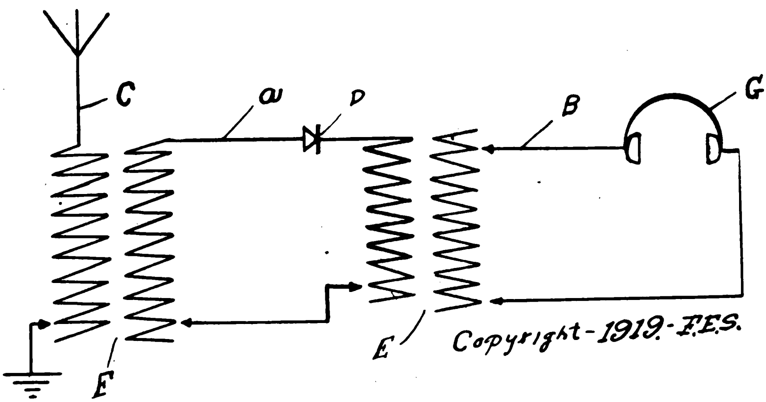


Fig. 43—Experiment illustrating the action of detector.

mary of an audio-frequency transformer, E. The transformer E having a ratio of winding 1 to 1, both the primary and secondary having 2000 ohms resistance, also a soft iron laminated core. Connected serially in the secondary circuit of transformer E is a pair of 2000 ohm telephone receivers. The action of this experiment is as follows: If groups of radio direct pulsations were going through the primary of transformer E, radio oscillations would be induced in B cir-

cuit, the magnetic power of these oscillations could only be the difference between the inverse and direct currents, that would vibrate the telephone receiver. In regard to inverse and direct currents see Art. 18. In this experiment a stopping condenser should be shunted across the primary winding of the transformer E, as is customary. There is a little difference between the magnetic power of induced inverse and direct currents, and it is only this difference that could operate the polarized telephone receiver, if radio direct pulsations were going through the primary winding of transformer E, the efficiency of this method should be very small. But this method is preferred by many of the greatest radio inventors, especially when Flemming or audion vacuum tubes are used. In this experiment I have found that the difference between the strength of the signals in A and B circuits seem to be only limited to transformer losses. This tends to show that the relation of local currents and the incoming groups of oscillations would be similar to Fig. 38 instead of Fig. 39. Another experiment in this direction would be to use instead of an audio transformer, an oscillation transformer, and have the second transformer tuned the same as the first or F transformer, omitting the stopping condenser in this instance. Now note the difference of the strength of signals in A and B circuits. It would seem to me that instead of a group of radio direct pulsations in the telephone receiver circuit, there is one direct pulsation for each group of incoming oscillations. This is illustrated better in Fig. 44. Graph O-1 represents the groups of incoming radio oscillations, graph O-2 single pulsations of direct current for each group of incoming oscillations in the primary circuit of audio transformer, graph O-3 single cycle currents in the secondary of audio transformer, for each group of incoming oscillations, and graph O-4 the the vibration of the diaphram of telephone receiver. There are several crystals and contacts of crystals and

dissimilar elements that generate local currents when electro-static oscillations pass through them. If crystal detectors are generators of local currents, they cannot be rectifiers in the sense they are known at present. So my theory is that instead of crystal detectors being rectifiers, they are generators of a local direct current in the telephone receiver circuit. Also that this current in the telephone receiver circuit is of much greater electro-motive force than the current

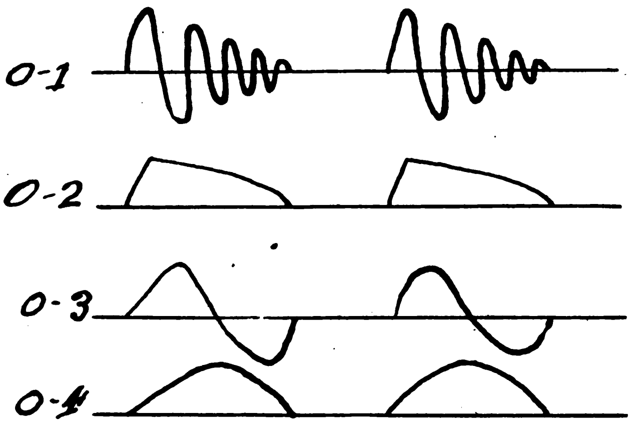


Fig. 44—Graph illustrating the relation of incoming oscillations, pulsations of direct current, alternating current and vibration of telephone receiver.

received in the antennae. Also the magnetic power of local current in the telephone receiver circuit is much more than that received in the antennae. Also that the crystal coherer and electro-lytic detectors are electric-static relays. The direct current resistance of crystal detectors is about 2000 ohms, so telephone receivers having a resistance of about 2000 ohms will of course give the best results. I also want to point out here that the magnetic strength of the

generated current in the crystal detector and telephone circuit, is several hundred times greater than the electro-static currents received in the antennae.

The power of electro-static attraction is illustrated in Figs. 3 and 5. Fig. 45 shows a modern damped

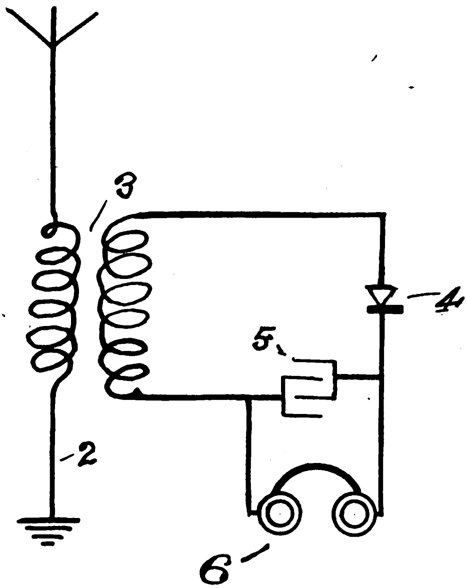


Fig. 45—Modern damped wave receiving system.

wave receiving system. A simple experiment to prove that a crystal detector will generate contact electricity is illustrated in Fig. 46. If a telephone receiver is shunted across a detector of this type, and with one hand on the insulated handle, you scratch the detector spring forcedly across the crystal, a loud grating noise will be heard in the telephone receivers, due to the generation of contact electricity.

69—Telephone Receivers. Telephone receivers are divided in two classes; namely, polarized and non-polarized. Non-polarized receivers can be used to

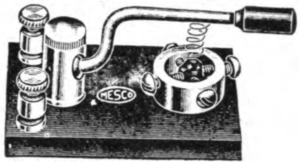


Fig. 46—A handy detector.

receive wireless messages to a certain extent without a detector, provided about 10,000 ohms of resistance is used. See Fig. 47. Non-polarized relays will function in like manner. In non-polarized receivers and re-

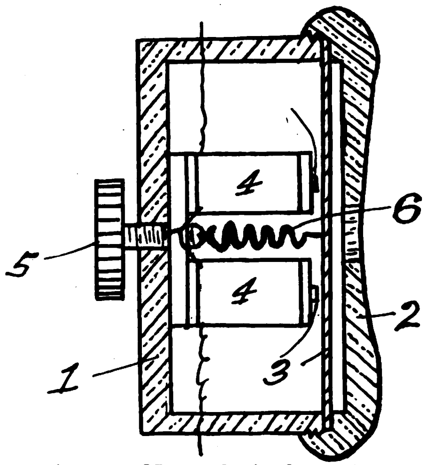


Fig. 47—Non-polarized receiver.

lays there is no permanent magnetic circuit in the vibrating electro magnets, the diaphram can be tuned resiliently, or magnetically if the magnetic circuit does not go through the vibrating electro magnets. In non-polarized apparatus laminations of the softest iron

should be used; then the incoming groups of oscillations will magnetize the core in either direction. In a polarized receiver and relay there must be a permanent magnetic circuit going through the vibrating electro magnets all the time. Soft iron or nickel laminations should be used in the cores for a polarized receiver. Polarized receivers are used at present for receiving wireless. The laws of resistance, magnetic strength and Ohm's law will give us more light on detectors. The very fact that electro-lytic detectors, crystal detectors and vacuum tubes have a D. C. resistance of about 2000 ohms, and when they are used in series with a telephone receiver of about 2000 ohms will give the strongest signals, shows by Ohm's law that the cause of the operation of above detectors, are to generate or alter a local direct current. If electrostatic currents went through the telephone receivers 2000 ohms receivers would be far from the most efficient, as receivers wound to 10.000 ohms or higher would give far better results. I believe this law can be applied to all detectors:—that the electrical resistance of the telephone receivers used, should have about the same resistance as the detector or detectors used. Also it would appear that in polarized receivers, if nickel were used in the cores, diaphram and rest of the magnetic circuit in telephone receivers, they should be more sensitive, as nickel is five times more sensitive to weak magnetic circuits than soft iron. Separate resilient or magnetic means could be used to tune the diaphram to certain vibrations per second.

By using a telephone receiver in combination with a modified form of Vernon Boys radio-micrometer I have received wireless efficiently with it. Wireless waves are used to generate thermo-electricity, which operates the receiver. The combination of a strong magnetic field, loops, thermo-couples and circuits seem to be more sensitive than the audion in detecting weak wireless currents.

CHAPTER 7.

ELECTRO-STATIC TUBES

70—Tubes as Detectors. In this chapter I will use the term, electro-static tubes to denote all forms of tubes, in which electro-static repulsion and stress alter the electrical resistance. These tubes are better known at present as the Flemming and audion vacuum valve or rectifiers. To these I will also add vapor, air and gas tubes at atmospheric pressure. Also tubes of vapor, air and gas in a rarefied state. Also any preferred mixture of gases at or below atmospheric pressure may be used in tubes. Science at present claims that the principles of operation of vacuum tubes are rectifiers or valves, when used as detectors for wireless. In certain heavy currents vacuum tubes will function as rectifiers, but I believe when used for the extremely weak currents such as are received in wireless, both direction of the oscillations go through the tube. Also that the action of vacuum tubes as wireless detectors are electro-static relays. In all forms of tubes as detectors of wireless I believe the electro-static power of repulsion shatters the conducting medium in the casing, thereby raising its resistance, and the telephone receivers are operated accordingly. A RECTIFIER OR VALVE COULD NOT FUNCTION AS AN AMPLIFIER. All tubes are good amplifiers.

In an amplifier some part of the resistance of the circuit must be raised or lowered, and the energy that causes this change in resistance, must be much less than the energy relayed. The laws of electro-static electricity make this possible.

Vacuum tubes are the most sensitive devices for receiving wireless waves at present, and are also the

best for cascade amplifications. A Marconi V. T. vacuum tube is illustrated in Fig. 48. This at present is by far the most sensitive device on the market for wireless. But in a short while probably even the vacuum tube as used today will become obsolete. Sensitive detection devices are yet in their infancy. When

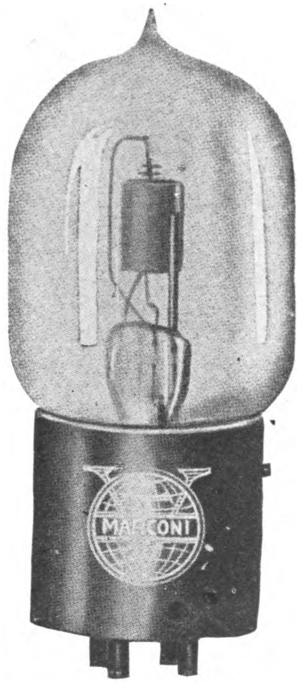


Fig. 48—Marconi-Moorhead V. T. vacuum tube.

the filament is raised to a certain heat, the heated vacuum becomes highly ionized, rendering it a good conductor of electricity. When the electro-static currents strike the grid and filament the conducting medium is repelled, thus raising the electrical resistance of the

tube, and a telephone receiver is operated. I would not like to say for certain whether or not this altered current was altered once or twice for each radio-oscillation, or once for a group of radio oscillations. In the former a group of radio direct pulsations would go through the telephone receiver and in the latter one direct pulsation for each group of oscillations. The former theory may be true for the lower frequencies and the latter for higher frequencies. See Art. 68. If the operation of the vacuum tube is caused by either or both of above theories, it could not be a valve or rectifier.

71—Principles of Electro-static Repulsion. One phenomenon of static electricity is that the electro-static repulsion is nearly as strong as the electro-static attraction. Whereas in magnetism, the magnetic repulsion of the best diamagnetic substances is very

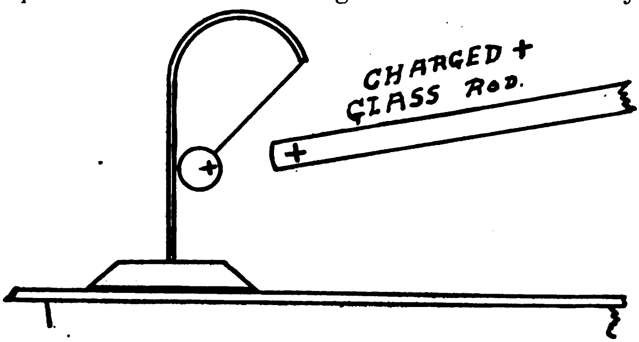
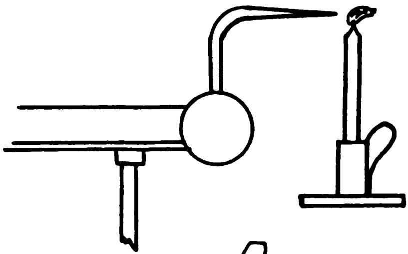


Fig. 49—Illustrating the electro-static repulsion of like electricities.

small as compared with magnetic attraction of magnetic elements. In Fig. 49 is illustrated the electro-static repulsion of unlike eletricities. In Fig. 50 is illustrated the electro-static repulsion of a flame. If a flame is held near a sharp point charged with static-

electricity, the flame is also repelled. If a flame (See Fig. 5) or lighted candle is held near the negative pole of a frictional or Wimshurst machine, the flame is repelled, if held near the positive pole the flame is at-



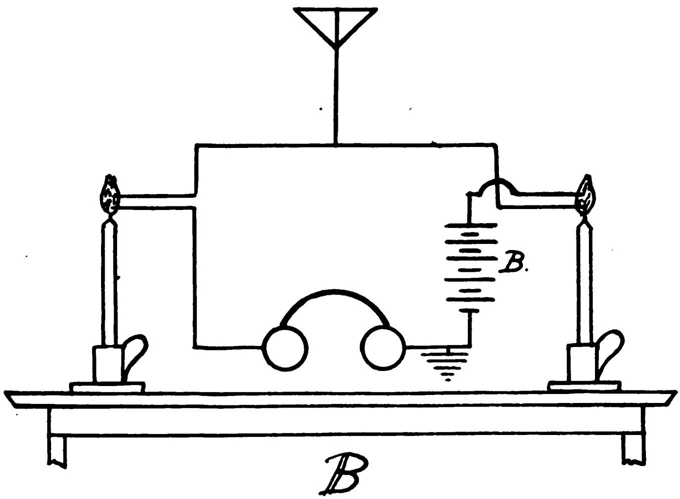


Fig. 50—Illustrating the electro-static repulsion of a flame, and flame detector.

tracted. Fig. 5 would also tend to show that the flow of current was from the negative to the positive pole. Fig. 50 and Fig. 5 seem to show the primary principle of operation of electro-static tubes. To get the magnetic power of a current, high resistance must be used in the form of an electro-magnet. To use the electro-static power of a current with a loose contact, certain elements and gaseous conductors can be used as electro-static relays or amplifiers.

Probably one explanation of why the repulsion of like electricities is almost as strong as the attraction of unlike electricities is because the intervening medium (the air) is attracted much stronger than the body with a like charge. Or in other words a neutral body is attracted far more than bodies charged with like electricities. An analogy of this is the attractive force of gravitation, air is attracted much more than an inflated balloon—Hence the balloon will be repelled by gravitation. Another anology is that air is attracted more by a permanent magnet than bismuth,—Hence the bismuth is repelled by the attraction of magnetism.

The electro-static principle of repulsion of a flame was used by Dr. Lee DeForest in his early experiments with vacuum tubes. A flame being a conductor for reasonably high voltage, when the flame is shattered by the repulsive power of electro-static electricity such as the oscillations received in the antennae, the local current is altered by raising the resistance of same, and the telephone receiver responds in like manner. This is also a good amplifier of extremely weak currents. (See Fig. 50B.)

72—Graph Showing the Summers Theory of Electro-static Tubes. Do the electro-static oscillations cause a local current to be relayed, once for every group of oscillations, once for each oscillation, or twice for each oscillation? I will try to explain these theor-

ies. Fig. 51 graph O-1 represents a group of incoming oscillations, five in number having a frequency far

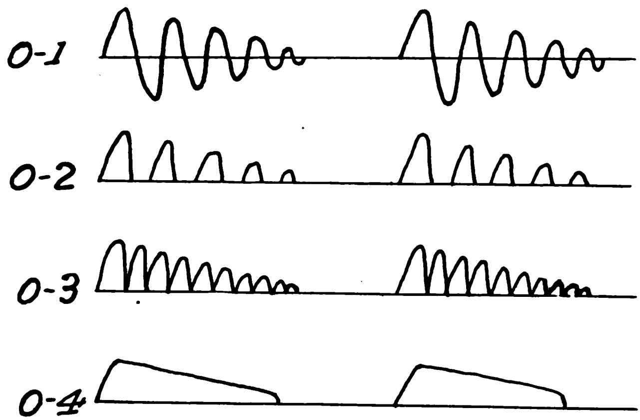


Fig. 51—Graph showing the Summers' theory of electrostatic tubes.

above audibility. Graph O-2 shows a direct pulsation of local current for each oscillation or frequency; there would be five in number of these radio pulsations of direct current. Graph O-3 shows two direct pulsations of local current to each oscillation; there would be ten in number or one direct pulsation for each direction of incoming oscillation. Graph O-4 shows a single direct pulsation for each group of incoming oscillations. Of course the direct pulsations in graph O-2 and graph O-3 would occur at a speed far above audibility, but the combined magnetic power of them would vibrate a telephone receiver once.

Where one electrode is used capable of emitting negative electrons as in the Marconi V. T. tube, the tube acts as a valve for the B battery, but the incoming

high frequency oscillations of wireless waves seem to go in both directions through the tube. But if a plurality of electrodes are used capable of emitting negative electrons, then the tube will not act even as a valve for the B battery as the current of B battery will go with equal ease in either direction through the tube as well as the incoming oscillations. These electrodes which emit negative electrons by repulsion or attraction from the positive electrode, may be at or near atmospheric temperature, such as radio-active substances, caseium, gallium, rubidium, potassium, mercury, sodium and similar substances. Also electrodes with high temperature such as an incandescent filament are better for repelling negative electrons. The valve action is caused by the natural attraction of electricity in one direction only. In one direction there is no conducting medium to be attracted and the circuit is broken, or vica versa. See Art. 122.)

73—De Forest Double Filament Tube.—Dr. De Forest who is the inventor of the audion, constructed a tube or bulb having two filaments and used it as a two element device. He claimed that rectification could not be the cause of the received signals with this device. As a filament was used both for the plate and the filament, both filaments being raised to incandescent state by separate A batteries, this seemed as sensitive as the regular Flemming tube. If graph O-2 Fig. 51 represented the action of present vacuum tubes, the DeForest double filament bulb should have been twice as sensitive as where only one filament was used, because in this case both directions of the received oscillations would go through the tube and each half cycle would alter once the local battery.

This would tend to prove that both directions of the incoming oscillations went through the vacuum tubes, and that the local current was altered twice for each oscillation. See graph O-3 Fig. 51. Or that the

incoming oscillations being millions of times per second, would continuously repel the conducting medium during the wave train. In this case graph O-4, Fig. 51 would illustrate this action. In Fig. 52 I show a Flemming valve circuit taken from "Cyclopedia of Telephony and Telegraphy, Vol. 4, American Tech-

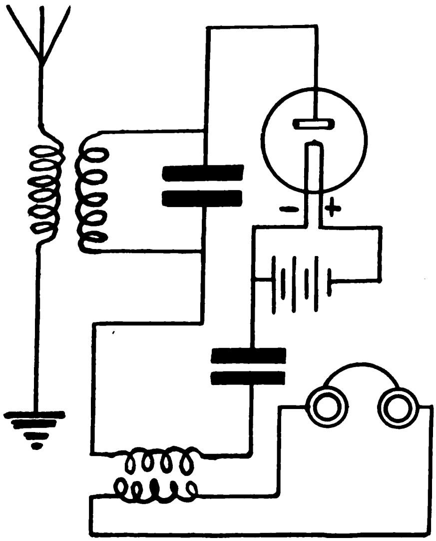


Fig. 52—Changing the uni-directional direct currents from a vacuum detector to oscillating or alternating.

nical Society". This would tend to prove that the action of vacuum tubes is illustrated in graph O-4, Fig. 51. A close analogy of Fig. 52 is Fig. 43. In Fig. 52 the telephone receiver is connected inductively to the uni-directional impulses flowing through the primary of the induction coil, as shown. If each oscillation caused one direct impulse in the primary circuit at a radio frequency, it would seem that radio oscillations would be induced in the secondary circuit, and that a detector

would be needed in the secondary circuit to give most efficient results. But when we read the statement of Prof. Flemming, who is the inventor of the Flemming vacuum tube, "that this arrangement, when suitably adjusted, is one of the best long-distance receivers for electric waves yet devised." From this fact it would seem that graph O-4, Fig. 51 described the action of vacuum valves or tubes. If the incoming oscillations caused uni-directional impulses in the primary circuit, radio oscillations would be induced in the secondary circuit. This is better explained in Fig. 53. Here is shown the induced, inverse and direct currents which flow in both directions in the secondary of an induction

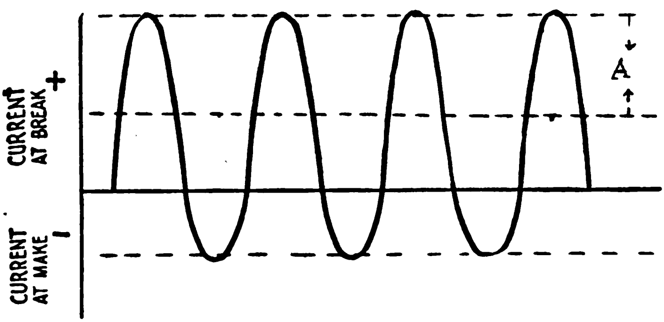


Fig. 53—Illustrating the magnetic power by the letter A, when radio direct currents are changed by a transformer to radio oscillations.

coil. The peak of the direct current, does not raise as high as the inverse current, but is of longer duration. There could not be much difference between the magnetic power of the induced, inverse and direct currents yet the difference of this magnetic power is all that could operate a polarized telephone receiver. See articles 18 and 67.

If there were rectified electro-static currents flowing through the primary winding of an audio-frequency

transformer for cascade amplification, a ratio of winding of one to one should give efficient results, but when we learn that a step up audio-transformer will give better results, it would seem to prove that electromagnetic currents were going through the primary of the audio-transformer. Audio-transformer as used mainly in cascade amplification for audions has a primary resistance of about 2200 ohms and a secondary resistance of about 9150 ohms. This steps up the unidirectional currents in the primary to a state of electrostatic currents in the secondary, wherein the electrostatic power of repulsion can be used over again to alter another circuit.

74—Edison Effect. Thomas Alva Edison, that great inventor long before Prof. Fleming patented his two element vacuum tube, used a two element tube or bulb. He took an ordinary carbon-filament glow lamp and sealed inside a platinum plate, not connected to the filament, but attached to a third terminal on the outside of the tube, then he found that when the lamp is worked with a continuous current a galvanometer connected in between the platinum plate and the positive terminal of the lamp indicates a current, but not when connected in between the negative terminal of the lamp and the plate. This is commonly known as the Edison effect. The action seems to be that electrical discharge consists of carbon molecules, or by bodies smaller than molecules.

Or is this action the continuation of the well known law in static electricity, wherein negative electricity is more easily discharged by a flame than positive, owing to the high resistance of the vacuum the electricity could only flow in one direction. The ionizing caused by the light and heat rays is also doubtless concerned.

A close analogy of the Edison effect would be the arc illustrated in Fig. 23. Here the carbon electrode is

the negative pole and the copper electrode the positive pole. Still another analogy is the mercury vapor lamp. Here the negative electrode is mercury and the positive electrode, iron. It would seem that the carbon and mercurial vapor formed between the two electrodes can only pass in the direction from the negative to the positive pole. This would also show that the direction of current, instead of being from the positive to the negative pole, as is supposed at present, is from the negative to the positive pole. These molecules or electrons would certainly have to flow with the general direction of the current. In a sense the Geissler tubes seem to be a close analogy of the Edison effect, as the particles of gas or electrons are viollently repelled from the negative electrode. Do these experiments in vacuum prove the directivity of the electric current? (See Art. 122.)

75—Open Air Audion. It has been generally supposed for a long time that a tube could not function as a detector, unless the Edison effect of a vacuum were used. Several years ago having my electro-static theory of repulsion in mind, I constructed a three element audion having the filament, grid and plate disposed in the open air at ordinary pressure. With this I received wireless, and of course made me more certain of my electro-static theory of repulsion. In Fig. 54 is illustrated one embodiment of an air audion, which is mounted on an insulated base 1, the filament 4 is preferably of some non-fusable wire such as platinum, climax, nichrome, tantalum, osmium, tungsten and similar elements, the grid 5 is disposed around the filament and the plate 6 around the grid. The filament is preferably disposed in the form of a straight wire, instead of the horse-shoe shaped filament as shown, placed centrally in the grid. This device will function as a detector and amplifier in open air. Dr. DeForest has just recently obtained a patent on

an open air audion, in which he uses a Nernst glow lamp as the heating element. The filament in a Nernst glow lamp consists of a thin rod of mixed metallic oxides, thoria zirconia, and ceria, looking like a short thread of pipeclay. This filament must be raised to a red heat, by artificial means, before it is a good electrical conductor.

If an oxide coated metallic filament be used, filaments may be effective in repelling negative electrons at a much lower temperature. If filaments be coated with substances capable of repelling negative electrons at a low temperature, such as radio-active substances, caesium, mercury, gallium, sodium, bismuth, thallium, zinc, calcium, barium and similar elements, then the filaments will repel negative electrons at a low temperature, and the filament can be used in vapor, air or gas at any desired pressure without fear of oxidization or melting of the filament. This will give the metallic filament of an air audion long life. The elements of an air audion should be closer together than when a vacuum is used.

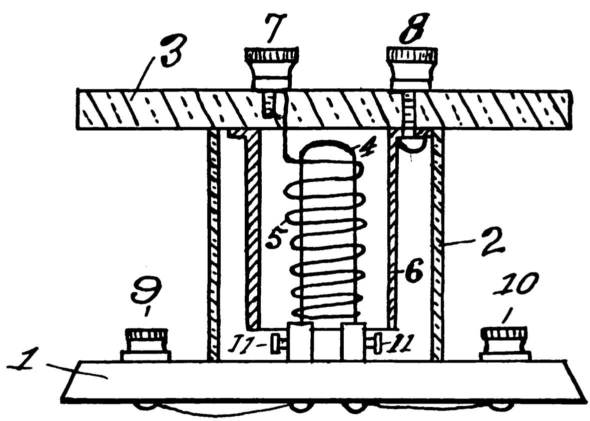


Fig. 54—Air Audion.

76—Heating Elements for An Air Audion. There are several different kinds of heating elements that can be used in open air audions. In Fig. 55 A is illustrated one form of heating element. This comprises a small tube of about $\frac{1}{4}$-inch in diameter which is sealed at both ends and having metallic ball electrodes, the electrodes being connected inside the tube by an incandescent filament. This snaps in between two springs and is held centrally in a grid, and a plate disposed around the grid. By this method the heating element of an audion may be quickly and cheaply replaced, when burnt out. These heating elements could be sold at 50 cents each and a good profit made. This tube is air tight and the chamber in which the filament is disposed is preferably of a vacuum or certain inert gases, such as nitrogen, helium, argon and the like, near atmospheric pressure. Also rarefied air or gas may be used. Vapor may also be employed.

The container of the filament is preferably of a transparent substance such as glass. If the glass has a high percentage of lead, or other conducting material, lower plate voltages may be used.

In Fig. 55B is illustrated a solid dielectric rod having fused or disposed therein an incandescent filament of a solid or fluid. (See Art. 75.)

77—Summers' Gas Audion. Knowing for many years that a vacuum was not necessary for the

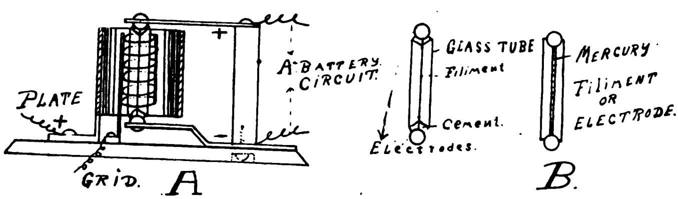


Fig. 55—Heating elements for an air audion.

functioning of wireless detectors, I filed applications for patents on air and gas audions. Vacuum tubes use a heated vacuum as the conducting medium. Air or the atmosphere is a mixture of gases at atmospheric pressure. The main drawback to burning a filament in the open air is that it will oxidize or burn up if a high degree of heat is reached, which is necessary in audions. If an inert gas such as nitrogen and similar elements be used in the casing at about atmospheric pressure, this trouble is overcome. Also there are many mixtures of inert gases that can be used, which will prevent the rapid burning of the filament. Although in a gas audion any certain gas or combination of gases may be used above, below, or at atmospheric pressure. Gases that have little or no oxygen are preferable, as oxygen gas greatly helps the burning of elements. Mercury and other vapors may also be used. Certain gases will no doubt be more sensitive to electro-static repulsion and stress than others. Any gas or gases may be used that are subject to electro-static repulsion and stress. Experiments should be carried out with all kinds of gases and combinations, including some of the rarer gases such as, argon, helium, carbonic acid, carbon dioxide and similar gases. Care must be taken not to use an explosive mixture, or serious results would follow. Geissler tubes can also be used as audions.

Gas tubes can be used for detectors, amplifiers, oscillation generators, wireless telephony and similar uses.

If these tubes be used with a gas or combination of gases, having a pressure the same as Geissler tubes, they are very sensitive, and lower plate voltages can be used. Also lower resistance telephone receivers.

Also if it is desired to increase the efficiency of the filament in emitting negative electrons at a lower temperature, oxide coated filaments should be used. (See Art. 75.)

78—Tubes with Pointed Electrodes. While the improvement of placing the grid co-axially around the filament and the plate around the grid was a great advance over the original DeForest audion, I believe this is not the most efficient form of electrodes. In crystal loose contact detectors a point is necessary for their efficient operation. It would seem that the combination of a flame and the high electrical density of sharp points would give better results. With pointed electrodes lower plate voltages could be used, also there should be a more marked change in the resistance of the conducting medium by electro-static repulsion of a given current. There is illustrated in Fig. 56 one embodiment of the pointed electrode tube. Of course this tube may contain a vacuum, air, gas or gases and a vapor at any desired pressure. With a device similar to this I have received wireless without the filament being heated, or the equivalent of three cold electrodes, by using certain conducting mediums in the casing. It may be proven in the near future that the A battery as now used in audions, is useless. Tubes may be used with vacuum valves for use with an air pump, then any degree of vacuum may be used. Thus the density of the conducting medium may be changed at will.

In Fig. 56 is shown a hot pointed electrode, but I have carried out some promising experiments with a cold electrode having a plurality of points for the negative electrode and a plate for the positive electrode. This acts partly as valve for B battery. The efficiency of this is increased by using certain substances for the points and conducting medium. If substances be used for points that will emit negative electrons at or near atmospheric temperature, such as radio-active substances, caesium,. gallium, mercurys rubidium, potassium, thallium, etc., cold electrodes will then to a certain extent emit negative electron, and the device can be used partly for a valve, provided

a positive plate is used for the other electrode. One of the preferable conducting mediums for this type of tube using a B battery only is rarefied air or gas having the same density of Geissler tubes. If both elec-

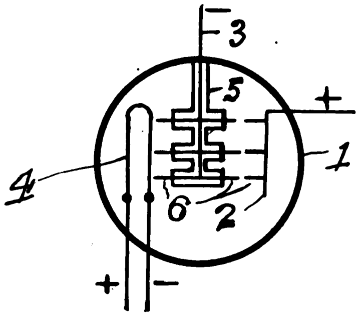


Fig. 56—The high electrical density of point applies to electro-static tubes.

trodes be pointed then the B battery will go with equal ease in either direction through the tube. In either case this form of tube will act as an amplifier, detector and oscillator. Points may be coated with above substances.

79—Vapor Audion. It is not very well known that a vapor can be used as a Fleming valve or audion. In Fig. 57 is illustrated a simple form of a vapor audion using as the negative electrode, mercury, (symbol HG). Here the vapor from the mercury allows the current to travel from the mercury to the iron or positive electrode, but not in the opposite direction because the attraction of electricity tends to carry the vapor back to the mercury, thus breaking the circuit in the opposite direction. The tube is preferably an evacuated tube. When the flexable conducting stream of vapor is carrying the attraction of electricity from the B battery through the tube, from the mercury to the plate, if a screen like grid be disposed in between and connected

to a source of oscillating current such as is received in a wireless antennae, then the conducting medium of vapor is shattered by repulsion and telephone receiver is operated accordingly. Both directions of oscillating current seem to go through the tube, probably altering the resistance of the tube in both directions. (See Art. 72.)

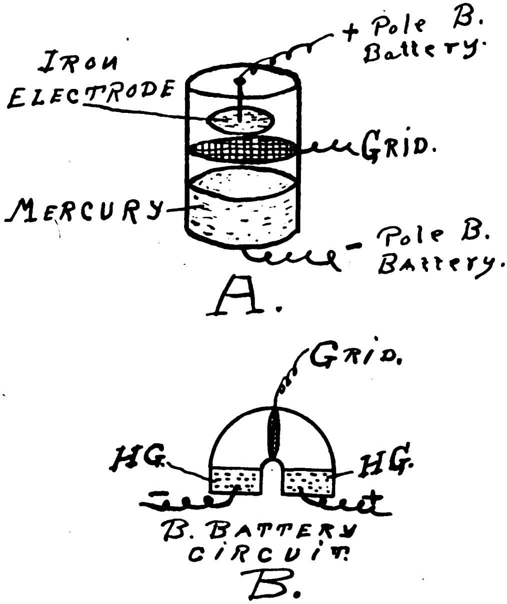


Fig. 57—Vapor audion.

It is not necessary that the Edison uni-directional effect of a tube be used to function efficiently as a wireless detector. So a tube can be used effectively wherein both electrodes for the B battery are capable of repelling negative electrons, as illustrated in Fig. 57B. Here two electrodes of mercury are disposed in a circular closed glass tube for the B battery circuit. The

conducting vapor in this embodiment will go in either direction, thus it is immaterial in which direction the current from the B battery goes through the tube. This flexible conducting stream of vapor can be shattered by electro or electro-static currents if connected electrically to a grid, which is disposed in the vapor path as shown. In this type of detector there is no question but what the attractive force of B battery is changed by both directions of the incoming oscilations, and the telephone receiver is operated thereby. With this type of device heavy currents can be controlled by a very small current. This is an excellent device for a detector, amplifier and oscillator. A close analogy of this, is the device described under Art. 73.

80—Oscillation Generators. Any conducting medium that is subject to electro-static repulsion, can also be used as a generator of damped or undamped waves. In using high power tubes for the production of radio oscillations for either undamped wave telegraphy or telephony, larger electrodes must be used for efficient results, than are used with a tube designed for detection purposes. One method of generating continuous waves is shown in Fig. 58. Here is what might be termed an invisable arc. The electrodes 1 and 2 are preferably disposed in a casing having therein some conducting medium, such as gas or vapor. When the direct current flows through the conducting medium, the self inductance of the primary and secondary circuits generates in oscillation transformer 6 sustained oscillations. The electrodes 1 may be both connected together and used as one electrode, and the filament the other electrode. In the former the arc circuit is used; in the latter the vacuum tube circuit.

Valves may be used in the casing connected to automatic means for keeping any certain pressure or vacuum in the tube.

81—Double Audion Circuit. Some light on the operation of tubes may be found by the experiment shown in Fig. 59. Here the electrodes of a Fleming tube are connected as shown with their polarities reversed, so that both directions of the incoming oscil-

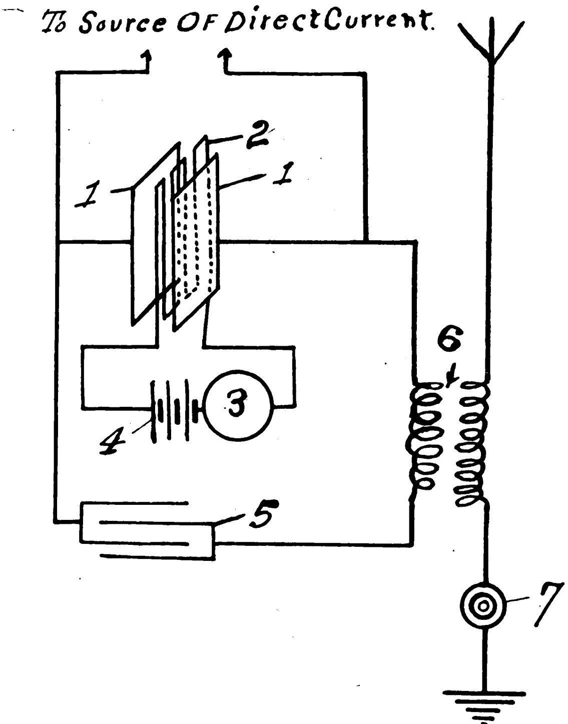


Fig. 58—Means to produce waves of constant amplitude.

lations can go through the tubes. If only one direction of the incoming oscillations is used in a single tube this arrangement should be twice as sensitive as one tube. For here undoubtedly both directions of the

oscillations can be utilized. Each telephone receiver should have the same resistance as each tube. A close analogy of this experiment is described in Art. 68.

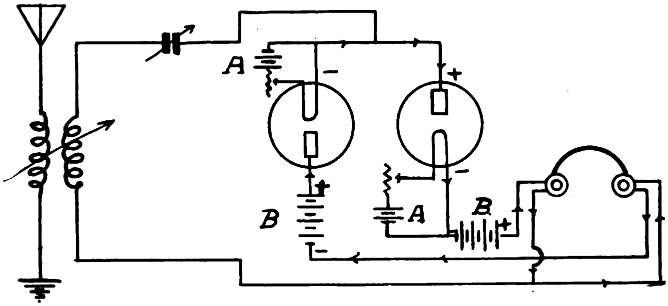


Fig. 59—Fleming valves with polarities reversed.

82—Serially Connected Tubes. When electrostatic currents go through a plurality of separated electrodes in a gaseous conducting medium, as shown in Fig. 60, is the electro-static power of repulsion three times as strong as if one tube is used? If so then ser-

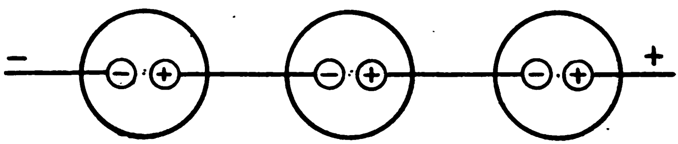


Fig. 60—Illustrating the change in resistance of serially connected tubes.

ially connected tubes as shown in Fig. 61 should be about three times as sensitive as one tube. In the latter circuit if Marconi V. T. tubes are used, then the resistance of the telephone receivers should be about 6600 ohms. If 2000 ohm receivers were used

with this arrangement, an audio-transformer having a primary of 6600 ohms and a secondary of 2000 ohms should give efficient results the secondary circuit connected serially with the tubes and the telephone receiver connected serially in the primary circuit. Tubes

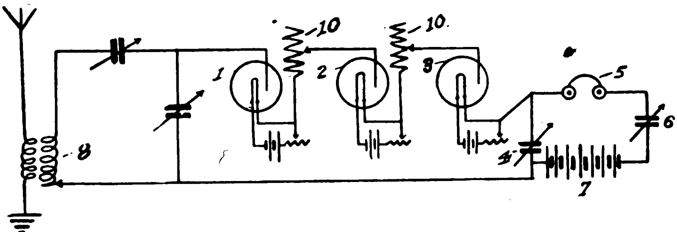


Fig. 61—One method of connecting electro-static tubes serially for increased results.

using a B battery only can be connected as shown in Fig. 62. In connecting tubes serially a condenser should be connected in series on each side of the receiving transformer, and separate tuning means should be used serially between each tube. There are also other ways to connect up tubes so the electro-static power of repulsion will be used over and over again.

83—Receiving Undamped Waves. I will not take space at present to describe undamped wave systems, only in a brief way. The action of the Poulsen ticker seems to be, that a local current is generated by friction, electro-static attraction and stress. In the slipping contact detector for undamped waves, the principle involved seems to be that a local current is generated by friction, electro-static attraction and stress, the breaking up of undamped waves to audio-frequencies is certainly caused by electro-static attraction and electro-repulsion. As one proof of local currents being generated by above devices I refer the reader to Ohm's law. See articles 12, 20, 23, 45, 46.

To be very brief in my explanation of the theory of undamped wave detectors I would like to advance the theory here that undamped detectors and systems such as crystal, slipping contact, and heterodyne systems operate on the principle of a buzzer under the steady influence of undamped waves. Also the howling of the telephone is another analogy. The fre-

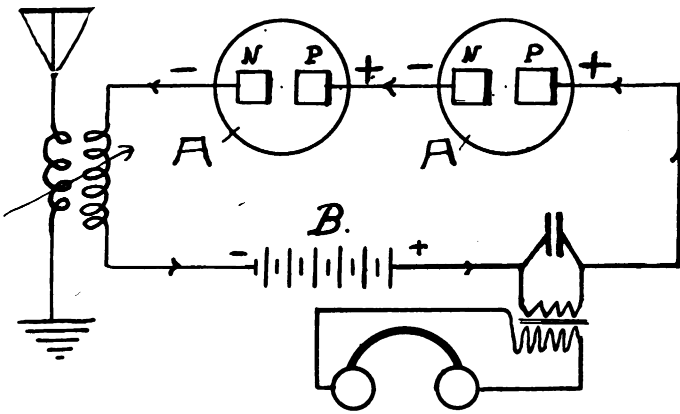


Fig. 62—Illustrating one method for tubes using B battery only.

quency of the beats or howling can be controlled by inductance. In using a crystal detector for receiving undamped waves a relative high voltage is necessary then there is both electro-repulsion and stress and electro-static attraction and stress. This will act as a buzzer without an electro-magnet. It is also possible to make a buzzer by using a resilient contact without electro-magnets, using a steady direct current only.

It seems that when the vacuum tube principle of heterodyne receiving is used, the B battery is altered in a similar manner by self-inductance. I cannot believe altogether in the present heterodyne theory of crystal detectors, vacuum tubes, Goldschmidt tone wheel, and other similar systems.

If in Fig. 39 graph O-2 represents the action of a crystal detector, then a crystal detector should act as an amplifier, if connected by step up transformers in cascade. In undamped waves an undamped detector should be used in the final stage.

84—Selenium Detector. No doubt but that the selenium cell is the most sensitive device for receiving weak electric currents that is known to science at present. This seems far more sensitive for weak electric currents than the audion, as a very little change in the intensity of light striking the cell will alter a local battery. This seems to be caused by the electrostatic attraction and stress of light. Tellurium and carbon and many other elements are also sensitive to light. Applying the use of above elements to receiving wireless should prove interesting. By subjecting selenium to a certain chemical process I have received wireless with it. The molecules of selenium and similar elements seem to be wonderfully sensitive to electrostatic stress.

85—Detectors of the Future. It does not seem that present detectors represent electrical and mechanical perfection. There are many different directions in which the future of detectors may trend. All detection devices are no doubt yet in their infancy. In electro-static tubes it seems that the vacuum will be displaced by other conducting mediums which will increase the efficiency, and simplify construction. Also efficient tubes may be used, employing a B battery only. Another direction of detectors may be using the electro-

static power of the incoming oscillations to vibrate a diaphram direct. There are no doubt many alloys yet to be discovered that will generate a direct current under electro-static stress as well as to alter a local current, or both. Rigid contacts of disimilar metals or alloys, will certainly come into use. New laws in electricity will be discovered and then applied to both the transmission and reception of wireless. Connecting detectors serially is also very interesting. If the electro-magnetic current which is the altered or generated current in the detector circuit, could be raised to a state of static electricity having rapid or radio frequencies, then any detector could be used as a cascade amplifier. We know very little yet in electricity, there is so much for us to learn. But we must keep at it,—study, experiment and work until the truth is found. Connecting detectors serially so that the electro-static power of the received currents can be used over and over, is a promising field.

A few arguments in favor of Summers' theory of detectors:—

1—Why does Ohm's law show a local or direct current is generated or altered by electro-static detectors?

2—Why do 2000 ohm receivers prove efficient on all wave lengths?

3—To get the best results from a detector why does a telephone receiver having the same electrical resistance as the detector give best results?

4—Why can the polarities of a crystal detector be determined by tables of contact or thermal electricity?

5—Why do selenium and similar elements change their resistance under the action of light and wireless waves?

6—If direct electro-static currents operate a telephone receiver why is not 10000 ohms resistance more efficient than 2000 ohms?

7—Why does a metal or conductor placed inside of a tuner decrease induction?

8—Why does an audio-step-up-transformer having a soft iron core prove more efficient for cascade amplification?

9—Why will a detector also function as an amplifier?

10—Why don't both directions of the electrostatic current go through the stopping condenser?

11—Does the stopping condenser act as a valve?

12—Why will tubes having a plurality of cold or hot electrodes, all capable of emitting negative electrons, act as a detector if valve action is the cause of the operation of audions and fleming valve?

13—If the audion is a valve when used as a detector, why will it amplify weak currents hundreds of times?

14—Why is it that it does not seem practical to amplify at radio-frequencies short wave lengths of 200 meters, without employing the heterodyne method of lower frequency?

CHAPTER 8.

EARTH CURRENTS

86—The Compass. It is claimed that the Chinese invented the compass. The compass is a small permanently magnetized magnet, delicately balanced on a pivot so as to be free to move. When this needle is disposed parallel to the lines of magnetic force which surround the earth, it will point nearly north. The magnetic north pole is not quite at the geographical north pole. The difference being about 1000 miles. Likewise the magnetic south pole is not exactly at the south geographical pole.

87—Inclination and Declination. Only in a few places on the globe does the compass point directly north. This variable phenomenon is called declination, and was discovered by Columbus in 1492. The declination and inclination being practically different all over the globe. Besides the slight variations of different localities, there are also daily, yearly and eleven year periods. Gilbert discovered that the reason that the compass needle pointed north, was because the Earth itself is a great magnet. We cannot consider the Earth a permanent magnet, because the Earth is generally composed of diamagnetic material, but a huge electro-magnet having a diamagnetic core. There are strong electric currents that continually travel around the Earth in the general direction of the lines of latitude, probably caused by several different means. The dominating causes seem to be that the Sun unequally heating the World causes thermo electric currents to circulate generally in a west and east direction. The rotation of the Earth doubtless is also directly concerned. The rays of light and heat from

the Sun (which seem to be electrical waves of short durations) are also partly the cause of earth and air currents. The declination of the compass seems to be caused by the difference of the general direction of the earth-currents. The difference of the conductivity and temperature of the surface of the Earth seems to alter the general direction of these currents. This might be the reason that the magnetic north pole, lies in the region of greatest cold. The earth currents flowing in an east and west direction would cause the compass needle to point at right angles to said currents,—hence the needle would point north and south. The daily and annual declination and inclination of the compass, seems to prove that the light and heat from the sun is the cause of the earth-currents which in turn causes the compass needle to point north.

It also seems that the causes of the Northern Lights are earth and air currents, also probably caused by the rays of the Sun and difference in temperature of the various zones. Of course the rarefied air is caused to glow in a manner similar to the vacuum tube. These currents are generally at right angles to the ground currents that cause the compass needle to point north. If the flow of electricity is from the positive to the negative pole, the directions of the earth currents seem to be from the east to the west. My theory is that the earth currents flowing from the east to the west is the sole cause of the compass needle pointing north. Also that the currents of electricity that flow at right angles to the compass currents are the cause of the Northern Lights. When the latter currents flow at right angles to the compass currents, they will naturally cause a change in the declination and inclination of the compass.

88—Signalling Without Batteries. The earth currents can be used for telegraphing or talking on a

grounded circuit as shown in Fig. 63 A wire is grounded at both ends, telephone transmitters 2 and 3, receivers 1 and 4 are connected serially therein. By this method conversations can be carried on between two stations without batteries. A portion of the direct

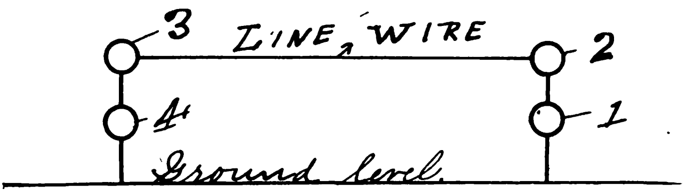


Fig. 63—How to use earth currents for telegraphing or telephoning.

current traveling in the ground is used instead. I also have made a buzzer to operate on earth currents. This seems to work better in an east and west direction.

89—Earth Battery. Ordinary earth can be used for the electrolyte of batteries if moistened with water. In Fig. 64 I show a glass jar 1 having disposed therein electrodes 3 and 2. The moist or wet earth is represented by the numeral 4. The electrodes are

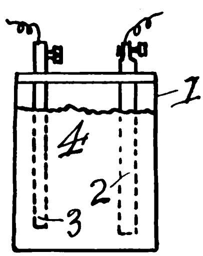


Fig. 64—Earth battery.

preferably of zinc and carbon. Although a very cheap battery can be made by using carbon and iron electrodes. Or using an iron bucket for the container and

one electrode and carbon for the other electrode. No other chemical is needed besides the moist earth to make a battery that can be used for talking or telegraphing. If a larger amperage is desired connect a plurality of these batteries in multiple. If higher voltage is desired connect in series. If higher voltage and amperage is desired connect in series multiple. If a little salammoniac be added to the moist earth the E. M. F. of the battery is increased. Above will last for years.

Enough water should be added to the earth to make a thick or thin paste.

This type of battery may also be embodied in the form of a dry cell.

CHAPTER 9

LIGHT.

90—Introduction. Light is a very interesting and difficult study. But yet I believe when the true causes for the many phenomena associated with light are discovered, light will be much more simple than was generally supposed. There have been several different theories advanced in the past for light. Among them were the Newton corpuscular theory, Huygens wave theory, and the Maxwell and Hertz electro-magnetic wave theories. The electro-magnetic theory of Maxwell and Hertz is accepted at present by science. Hertz proved that the wireless waves as used for wireless telegraphy and light waves are identical. The electro-magnetic theory of the propagation of wireless waves, seems to be losing ground. If the electro-magnetic theory of wireless is wrong then the electro-magnetic theory of light is also wrong. My study and experiments tend to show that light waves, like wireless waves, are pure electric waves, instead of electro-magnetic as is generally supposed at present. Practically all the difference there is between my theory and the theory of Maxwell and Hertz, is in the character or nature of the waves. What is light? Light is certainly electricity in extremely short pulsating or oscillating waves. If there was a definition for electricity there would be a definition of light I will have to be brief in this chapter, as it would take a book to treat this subject fully.

In the beginning during the first day of the creation of the Universe, God said, "Let there be light, and there was light!" Was this the creation of electricity?

91—Newton's Corpuscular Theory. Until the beginning of the 19th century physicists were divided between two different views concerning the nature of optical phenomena. According to the one, luminous bodies emit extremely small corpuscles which can freely pass through transparent substances and produce the sensation of light by their impact against the retina. This emission or corpuscular theory of light was supported by the authority of Isaac Newton, (Newton, Opticks, London, 1704) and, though it has been entirely superseded by its rival, the wave theory, it remains of considerable historical interest. (This article extracted from the article light, Enclyclopedia Britannica.)

92—Maxwells Electro-magnetic Theory of Light. Clerk Maxwell in 1864 advanced the present electro-magnetic theory of light. He noted the speed of light and electricity were practically the same, the former travelling in electro-magnetic waves. After Hertz discovered that a spark gap had the power to send out waves similar to light only invisible, which he called electro-magnetic waves, found them capable of reflection and of general refraction in a manner similar to light. Then the electro-magnetic theory of Maxwell was applied to wireless transmission, and has been used by science up to the present time. The present explanation of electro-magnetic waves is a complex problem. I will try to explain them in a brief way as follows:—"Once an electro-magnetic field is established, any change which alters the prevailing conditions is said to be an electro-magnetic disturbance. When a current of electricity increases in strength, the field around it increases also, the lines of force spreading out from the conductor like ripples in a pond; but when the current is decreased, the lines of force contract, closing in around the conductor, and the energy of the field shrinks back into the system. If this process be aug-

mented so that the periodic reversals of current produce oscillations of extremely high frequency, then, at each reversal, part of the energy of the field radiates off into the surrounding medium as electro-magnetic-waves and only a part of it returns back into the system. (See "Cyclopedia of Telephony and Telegraphy" Vol. 4. American Technical Society.) See Art. 30.

93—Maxwell's Theory Confirmed by Hertz. In 1888 Heinrich Hertz confirmed the electro-magnetic theory of Maxwell by his oscillator and resonater. (See Art. 60.) This experiment seems to be to prove conduction of electric waves through space, instead of electro-magnetic induction. The reader will note that the sparks produced in resonater are parallel to the primary spark or line of oscillation. If induction was the cause, sparks in the resonater should be produced at right angles to the primary spark as well as parallel to it, as the same number of lines of magnetic induction would be cut in either instance. I believe it will be proven in the near future that wireless travels the air by conduction instead of induction, and that Hertzian electric waves will be more appropriate than Hertzian electro-magnetic waves. In applying the conduction theory to wireless and light (or visible and invisible light) certain phenomena seems to be more simple, and easier understood.

Hertz gave experimental evidence that wireless waves and light waves were identical in many respects. That they could be brought to a focus the same as light waves, and could also be reflected, refracted and polarized in a manner similar to light. But light will not go through a fog, but wireless waves will. Neither will light go through the walls of houses, but wireless waves will go through with ease. Further on in this chapter I will try to account for this and other similar phenomena. (See Articles 97 98, and 122.)

94.—Early Theories of Light. (This article is extracted from the article "light" eleventh edition of Encyclopedia Britannica, which is no doubt the best authority on the subject.)

"Light, may be defined subjectively as the sense-impression formed by the eye. This is the most familiar connotation of the term, and suffices for the discussion of optical subjects which do not require an objective definition, and, in particular for the treatment of physiological optics and vision. "Emission theories," based on the supposition that light was a stream of corpuscles, were at first accepted. These gave place during the opening decades of the 19th century to the "undulatory or wave theory" which may be regarded as culminating in the "elastic solid theory"—so named from the lines along which the mathematical investigation proceeded—and according to which light is a transverse vibratory motion propagated longitudinally through the aether. The mathematical researches of James Clerk Maxwell have lead to the rejection of this theory, and it is now held that light is identical with electromagnetic disturbances, such as are generated by oscillating electro currents or moving magnets. Beyond this point we cannot go at present."

"To quote Arthur Schuster (Theory of Optics, 1904), 'So long as the character of the displacements which constitute the waves remains undefined we cannot pretend to have established a theory of light.' "

"It will thus be seen that optical and electrical phenomena are co-ordinated as a phase of the physics of the "aether," and that the investigation of these sciences culminates in the derivation of the properties of the conceptual medium, the existence of which was called into being as an instrument of research. The methods of the electric solid theory can still be used with advantage in treating many optical phenomena,

more especially so long as we remain ignorant of the fundamental matters concerning the origin of electric and magnetic strains and stresses; in addition, the treatment is more intelligible, the researches on the electro-magnetic theory leading in many cases to the derivation of differential equations which express quantitative relations between diverse phenomena, although no precise meaning can be attached to the symbols employed. The school following Clerk Maxwell and Heinrich Hertz has certainly laid the foundation of a complete theory of light and electricity, but the methods must be adopted with caution, lest one be constrained to say with Ludwlg Boltzmann as in the introduction to his, 'Remarks on Maxwell's Theory of Electricity and Light':—

> 'So shall I then with bitter sweat
> teach you what I don't know myself'."

95—Displacement Currents. It is claimed that there are three different forms of currents at present, namely, conduction, convection and displacement. The latter seems to be a continuation of the law of conductors and insulators as described in Art. 17. Also as the frequency of the current is raised the resistance of insulators is lowered. In wireless frequencies the air becomes a good conductor, and visible light frequencies a cold vacuum becomes a good conductor for electric waves. (See books on Electricity and Magnetism for a present explanation of displacement currents.)

Generally, in speaking of induction in this book I mean the attraction induced at right angles to magnetic or electric attraction, or vica versa. Any attraction parallel with or the continuation of a circuit I refer to as conduction. For instance electric currents are induced at right angles to the magnetic circuit, and vica versa. In a horse-shoe magnet the air completes

the magnetic circuit. In a wireless antennae and ground the air completes the electric circuit. Induction is at right angles to the latter two phenomena, and not a part of the circuit.

The Hall effect tends to prove that light is electric waves, in the polarization of light, and not electro-magnetic waves as is supposed at present.

Conduction, convection and displacement currents seem to all be caused by electric attraction across the intervening medium. In the two former the attraction is being rapidly discharged, in the latter it seems to be practically stationary.

96—Conductivity of Dielectrics. It is claimed at present that electricity will go through by displacement the dielectric of the condensers used in telephony and in series with a dynamo. Also it is claimed there is a small conductivity of gases. (See articles conduction—electric, Enclycopedia Britannica.) It is impossible to keep an insulated conductor charged with electricity when exposed to the air, as the charge slowly disappears. This is more rapid when exposed to light. Light no doubt ionizes the air in a manner similar to X-rays and radium, causing the air to be a better conductor for electricity. If we view light from the theory of extremely short waves of electricity, it is easy to understand why the air would become a better conductor for electricity, when under the influence of light. It seems that displacement currents are a continuation of the law I explained in Art. 17, simply conduction currents through a supposed dielectric. But whether or not wireless waves, and light waves, travel in the form of displacement-currents, or conduction-currents, their efficiency can be determined by the conductivity or character of the natural media. But I believe that wireless and light waves are transmitted by pure conduction-currents (as I will explain better farther on), instead of displacement-currents.

Telegraph and Telephone Age, prints the following in comparing the insulator 'air' with other insulators, in Feb. 16th, 1920 issue.

> "Pure water has a resistance eight-tenths that of air. Beeswax, ebonite, dry paper, paraffine, and para rubber a resistance twice that of air. Common glass, gutta-percha, impregnated paper, and shellac, a resistance three times that of air. Mica and porcelain, a resistance four times that of air. Vulcanized rubber compounds have a resistance six times that of air; heavy flint glass a resistance ten times that of air. These figures assume equal cross-section of materials and air; the air at ordinary pressure."

(Above table is doubtless for low voltage and frequency currents.)

The reader will note that the resistance of above substances compares favorably with the inductive table given in Art. 11.

Or in other words an air condenser having 10 square inches of plate surface, would have no more resistance than a condenser having pure water as a dielectric, with 8 square inches of plate surface. Or that a condenser having flint glass as the dielectric, with 100 square inches of plate surface would present no more resistance to the flow of electricity, than a condenser having water for the dielectric, with 8 square inches of plate surface. Or in other words the water, air and glass condensers above should each have the same capacity.

Still another illustration. Take an inverted L type of antennae 125 feet long by 10 feet wide (the open wires of an antennae are the equal of the same size in a solid metal sheet) would equal 1250 square feet. The

resistance of rain water is about 100 times less than air, then the conductivity of the air would equal a vertical column of rain water between the antennae and ground, having a cross section of 12½ square feet. The conductivity of the air above the antennae would equal about the same. Water is a good insulator for electricity of low voltages but is considered a good conductor for higher voltages, such as static electricity. When we learn that the resistance of the air is only 100 times the resistance of rain water, will any body say that conduction does not take place from an antennae. Then conduction also increases with the frequencies as well as when voltage is increasing. I believe dielectrics have a far greater conductivity than is generally supposed to currents of high pressures and frequencies. (See articles 39 and 40.)

(Also see articles; insulators; and, "Resistance of insulators", in "The Study of Electricity for Beginners", by Norman H. Schneider.)

I will make another mental illustration of the conductivity of the air. If pure water has a resistance of only 8-10 that of air, then with an antennae of 1250 square feet, the conductivity of the air between the the antennae and ground, and between the antennae and the rarefied air above, would equal a vertical column of water, extending from the ground through the antennae to the rarefied air above, having a cross section of 1000 square feet. In these mental illustrations the resistance of air is taken as 4 billion, pure water 3 billion and rain water 41 million times that of copper, at low voltages.

The resistance of a dielectric when in a field of varying intensity, is less than when the field is of a constant strength. Hence, the difference in the frequency of the electric waves is one cause for determining the conductivity of a dielectric.

97—Nature of Light. There is probably as much difference between the nature of light and wireless, as there is between the nature of wireless and direct currents. It is claimed that the eye is sensitive to certain vibrations, and that when these vibrations hit the retina, the sensation of light is the result. The range of vision is in vibrations between 430 to 740 trillions per second. At frequencies above the visible frequencies are the invisible frequencies of which is often termed invisible light, that is, the ultra-violet rays (above the violet end of the spectrum) and X-rays which represent vibrations ranging from about 870 to 1500 trillions per second. Below the lower, or red end of the spectrum are the infra-red rays from 300 to 430 trillions per second. The heat waves represent frequencies of about 20 to 300 trillions per second. Owing to the rapid vibration of these waves they are extremely short. (See Art. 58.) (Wave lengths abstracted from, "How to become a wireless operator" by Charles B. Hayward.American Technical Society, Publishers, Chicago.)

The voltage or potential of wireless waves is far more than low voltage currents. So light waves must have a voltage or potential far higher than wireless. No doubt the energy or amperage of light, is surprisingly small as in wireless. Light waves, seem to be pure electric waves, traveling the natural media.

Does the discovery that heat can be generated in a crystal detector by electro-static oscillations after they go through the air having a temperature far below zero, and through substances such as glass, generate heat enough in certain elements to cause a local flow of electricity, teach us, how, that light waves coming to use from the sun through space having a temperature far below zero, can cause the air and other substances to become heated under the electro-static stress of light. This is also the reason that we can see

farther in high alt'tudes. The light waves being stronger, or in other words they are not absorbed so much by the air and changed into heat. The denser the air in the same zone, the greater the heat generated.

98—Reflection of Electricity. Does electricity possess some unknown law of reflection, when generated in extremely short wave lengths of high voltage? I believe it does. If wireless waves are simply pure electric waves, light must be very similar. As the shorter the wave length, and the higher the voltage becomes in wireless, the more efficient is the reflection of wireless waves. Certain substances will reflect light, while other substances will let light pass through to a great extent. Thin sheets of glass and similar substances, allow the light to pass through. Is this because in transparent substances, the vibrations go through practically unaffected, or in other words these substances do not stop the rapid vibrations of light? Substances that are not transparent to light stop the electrical vibrations, soon as light comes in contact with said substances. Without light air is dark, but when there are visible vibrations in the air it becomes illuminated and substances that stop these electrical attractive waves of force are easily seen.

99—Ionization by Light Waves. Are light waves extremely high frequency electric waves, of an oscillating or alternating character, or is light extremely rapid direct pulsations of negative or positive electricity? The discovery of Hertz, in 1887, that the incidence of ultra-violet light on a spark gap facilitates the passage of a spark, led to a series of investigations by Hallwachs, Hoor, Righi and Stoletow, on the effect of ultra-violet light on electrified bodies. These researches have shown that a freshly cleaned metal surface, charged with negative electricity, rapidly looses its charge, however small, when exposed to ultra-violet light, and that if the surface is insulated and without

charge initially, it acquires a positive charge under the influence of the light. One explanation of this phenomena would seem to be that untra-violet light, were direct pulsations of positive electricity. If the metal plate is positively electrified, there is no loss of electrification caused by ultra-violet light.

Sunlight is not rich in ultra-violet light, and does not produce anything like so great an effect as the arc light. Elster and Geitel, who have investigated with great success the effects of light on electrified bodies, have shown that the more electro-positive metals loose negative charges when exposed to ordinary light, and do not need the presence of ultra-violet light. If certain substances are charged with negative electricity, the light from an ordinary petroleum lamp will discharge negative electricity. They also found that if certain substances were negatively charged, the discharge can be produced by the light from a glass rod just heated to redness; but there is no discharge until the glass is luminous. It seems a general law can be used; that all heat, visible and invisible electric waves cause an ionization of the air. That is the electric waves of light render the air a better conductor. When the air has a certain resistance, such as after night, the air between the rarefied air and ground has a greater resistance, hence wireless messages will travel farther. When the lower layers of air become ionized as in the day time, the air is a better conductor, and consequently the shunting of the wireless currents is more efficient. Hence, wireless messages will travel much farther after night than in day time. Heat, which is certainly electrical waves, also has the same or greater effect in ionizing the atmosphere. Hence, in tropical climates the air is a better conductor, and also more easily shunts the wireless messages or currents. Also heat waves have a longer wave length than light, this also helps to absorb wireless waves more than light. This is certainly one reason why to transmit in tropical

climates, long distances, high power and long wave lengths must be used. Light and heat waves seem to also neutralize or polarize wireless electric waves.

There is also a great difference in the distance wireless messages will travel over the sea and land. Wireless can be sent about three times farther over the sea than over the land. The cause of this is certainly that over the land there are millions of conducting objects extending up in the air, such as trees, buildings, mountains, etc. The needle like points of trees, exposed to the air act as sharp points of high electrical density to shunt the wireless currents. Then the difference of moisture in the air causes a wide difference in the conductivity of same. Both over the sea and the land, as well as in the day time and after night. Light and heat seem to greatly absorb wireless waves, probably on account of them being all electric waves.

There is a great difference in the distance messages can be sent over land. Dry and wet climates seem to make a great difference. In dry places messages can not be sent so far as in wet places. Moisture in the ground and air seem to help govérn the principles of wireless transmission. Over the sea there is much more moisture in the air generally than over the land. But we must remember that the density of the air is much greater over the sea than over the land. As over the sea the density is all the same, sea level. But land is all higher than the level of the sea, hence the air is more rarefied and a much better conductor in a certain sense. Especially the high table lands and mountainous countries. The conductivity of the air over the land is inversely proportional to the pressure. The efficiency of wireless transmission can certainly be determined by the conductivity of the air and absorbtion by heat and light. In studying the effects of light we must not forget the simple law in electricity—that electricity produces a chemical action. And a chemical action produces electricity.

Also in considering the conductivity of the air, we must not forget that as the frequencies are raised the resistance of the air is decreased and vica versa. So naturally in transmitting long distances, or in a tropical climate, long wave lengths are more efficient, owing to their lower frequency. A certain frequency will sometimes be more efficient for a certain distance.

100—Generators of Light Waves. The most efficient means we have at present to generate light waves is by a flame, red and white hot substances heated to an incandescent state. A flame or its equivalent, seems to vibrate within the range of the human eye, causing it to become visible, at the same time generating electricity of billions of volts and sending them out through space, the vibrations of the flame causes the vibration of the electrical currents in like manner, causing them also to be visible. (Or light may be a low voltage at a high frequency). I believe every movement whether small or large causes electricity, as well as every chemical action. Even the movement of the finger or raising of the arm, causes a separation of the electricities to take place. Sensitive electrostatic detection devices will become so sensitive in the future, that the raising of the hand can be detected for hundreds of meters, by the electricity it will generate. Do all bodies glowing at a red or white heat send out electric waves? They seem to. There are several substances that glow visibly without heat, these are called cold light. Such as phosphoresence, fire-flys, etc. This cold light seems to vibrate within the range of vision, and sends out electric waves, which are also visible. Many substances and crystals become luminous when exposed to the action of ultra-violet and X-rays. For instance take an ordinary electric light or bulb, nearly all of the current is used in heating the tungsten filament, the energy converted into light is very small, probably less than 1-1000 of the original

energy. The efficiency of electric lights is certainly less than 1-1000 per cent. The problem is to convert more of the electrical energy direct into light waves. Probably some day this will be done far more efficiently without the use of heat. Nature in the form of the fire-fly points in this direction..

If wireless waves could be made so short as to be visible, having a low voltage, they could certainly be sent out from a wireless antennae, and follow the contour of the earth. When more efficient means are found to change direct electric currents into visible electric waves this will no doubt be possible. There are many laws in electricity that are little understood, and no doubt there are many laws yet to be discovered. When we know more about electricity this may seem much more simple.

Voltages and frequencies of electricity which are used for wireless transmission follow the contour of the Earth because they flow in circuits, these lines of conduction take the form similar to the lines of magnetic force about a magnet. But when electricity is embodied in the form of light having short wave lengths the electric waves seem to travel in straight lines from their source, and can be reflected. Light can be polarized and reflected by a magnet. If light is pure electric waves, this could certainly be accomplished, for electric currents can be polarized and reflected by a magnet. (The twisting of the brush discharge from the pole of a permanent magnet is an analogy).

High frequency currents will go through any known insulator, including a vacuum. When the moon passes between the earth and the sun the light vibrations in the ether are stopped, and darkness is the result.

Electric currents having the pressure and frequency of light will travel by conduction through millions of miles of a vacuum, or ether, with the speed of

electricity. These visible currents as they come to us from the sun (probably by reflection from a positive electrode) for great distances in their travel they have a temperature of 60 degrees Farh. below zero, but when these high frequencies strike the air and earth they generate heat and electricity in a manner similar to a crystal detector.

Electricity in wireless frequencies must have a circuit. But electricity in heat and light frequencies seem to travel in straight lines or waves from their source. Take for instance bodies capable of emitting light, such as the Sun, radium, fire, cold light, etc. It would seem that the energy within said bodies generated electricity faster than it could hold same, and was repelled off in straight lines into space in heat, visible and invisible light frequencies, because space was charged less electrically and attracted same. An analogy would be a balloon being repelled from the earth. Another analogy would be the attraction of unlike electricities.

Another analogy would be charging a body with electricity, it can only hold so much, when this state is passed electricity is forced off in the surrounding medium.

It seems that wireless transmission is electric conduction through the natural media, because the currents follow the contour of the earth. But when electric waves leave in straight lines from their source, such as from the Sun, cold, fire, static charge, electric bulb and fire, the energy here might be in the nature of displacement currents instead of purely conduction currents, as it would seem impossible that convection currents could act across millions of miles of space. But whether light is transmitted by purely conduction or displacement currents, short waves of electric attraction seem to be the only cause of light, acting through space. Both wireless and light seem to be

an electro-static, instead of an electro-magnetic phenomena. And that Hertzian electro-static waves should be far more appropriate than Hertzian electro-magnetic waves, in referring to the dominating principle of the transmission of wireless and light.

101—X-Rays. Prof. Roentgen in 1895 while experimenting with a Crooks tube discovered that some kind of invisible light was generated and emitted outside of the tube. To this peculiar phenomenon he gave the name X-rays. They differ from ultra-violet and other invisible rays in being incapable of refraction, or of regular reflection. These rays pass freely through aluminum, zinc, wood, paper and flesh, but not through lead, platinum, glass or bone. These rays vibrate from 840 to 1500 trillions of times per second, and are of course invisible to the eye. But when these rays strike certain objects, they cause them to become luminous. If a screen of these substances be used then X-ray shadows can be seen or a photographic plate may be used for taking X-ray pictures of objects. The conductivity of certain substances is better than others, thus a shadow is cast. Bones do not conduct as well as the flesh of a person, consequently the outlines of same can be either photographed, or will show up against a flourescent screen.

X-rays seem to be short wave lengths of negative electricity reflected outside of the tube. These electric waves will discharge bodies both negatively or positively electrified. X-rays cause the air to become greatly ionized.

At low frequencies electricity seems to penetrate a conductor, at high frequencies electricity seems to travel on the surface only, and at still higher frequencies such as X-ray, conductors of a low voltage are again penetrated.

X-rays seem to possess far more energy than light waves, as the air after being ionized by light waves, is further ionized by X-rays. If some means of tuning could be used whereby the X-rays would vibrate with in the range of the human eye, the space traversed by the X-rays would no doubt be of a dazzling brightness.

When X-rays strike certain substances they become visible. Is this a continuation of the law in crystal detectors whereby the vibration of the incoming oscillations is divided by two? Some substances might send out a steady direct current under the influence of oscillations and other substances might send out a single pulsation for each oscillation. (See Art. 68). It seems that the electro-static stress of X-rays causes a chemical action of some kind to take place which makes certain substances vibrate within range of the human eye, and send out visible currents into space.

The voltage and frequencies of X-rays seem to be controlled by the resistance of a vacuum, thus a high vacuum will send out rays that have great penetration, and a low vacuum of lesser penetration. The latter are better for X-ray work because the difference in density of an object shows up better in a photograph or on the flourescent screen. Where a high vacuum is used the voltage of the rays is raised until they will go through practically all substances the same. Would X-rays be reflected from a tube of zinc filled with compressed air having about the same resistance as a soft vacuum?

If X-rays could be made to vibrate within range of the human eye, would the body of a person become transparent to the naked eye?

It seems that when vibrations of electricity in the form of visible or invisible light, strike certain sub-

stances, a chemical action takes place, rendering said substances visible and emitting light. Rays above the violet end of the spectrum cause a lower vibration in many substances and rays below the violet end of the spectrum cause an increase in vibrations, in either case certain substances will become visible. In all circuits the negative electricity is attracted by the positive, or that negative electricity is repelled from a positive electrode. The discharge of the electro-scope by radium rays, seems to prove that the rays are electricity.

102—Phosphorescence. Bodies that emit a pale light due to several different causes, not seemingly caused by combustion, are termed phosphorescent bodies. The word was first used by physicists to describe the property of many substances, becoming themselves luminous after exposure to light. This can be termed cold light, and may become the commerical light of the future. The peculiar phenomena of certain substances to emit light after exposed to same is a very interesting study we know very little about it. I would like to mention one theory:—does the electro-static stress of light cause a similar vibration in certain substances, which after the light has been removed, the vibrations keep on going for quite a long time, sending out in space visible electric waves. The electro-static stress set up by light seems to last a long while after the light has been removed. Is an anology of this the residual charge of a permanent magnet? In a permanent magnet the stress remains long after the magnetic field has been removed. Electricity and chemistry are closely related. Is another analogy the condensor?

Phosphorescence seems to be caused by a chemical action in a manner similar to a flame and radium. Here is a very promising field for research. Light will cause a chemical action and a chemical action will produce light.

103—Radium. Radium is a metallic mineral being obtained from pitchblende, a uranium mineral, by P. and Mme. Curie and G. Bemont in 1898. It sends out intense radioactive emanations into space. Radium is visible to the eye, as it vibrates within the range of vision. Radium is known to send out three different kinds of rays. They are known as alpha, beta and gamma rays. All these rays seem to be electric waves. The alpha being positively charged, the beta rays mainly negatively charged. The gamma rays seem to be identical with Roentgen's rays, and have high penetrating power. A sheet of paper will stop the alpha rays. But the beta rays will go through sheets of aluminum, glass, etc., several millimeters thick. The beta rays also resemble the kathode rays of a Crooks tube. If the eye can only see objects which vibrate from 430 to 740 trillions of times per second, radio-active substances must vibrate at this rate, it is evident that such vibrations would set up an enormous stress, which would generate heat, electricity, etc. This would send out waves of electricity into space having the same vibrations, which would be visible. But those vibrations of radium which are above the violet end of the spectrum, would not be visible, unless they were directed against some flourescent substance.

Radium seems to be due to some chemical law, which causes such high vibrations to take place, which come within the range of vision, and more commonly known as visible and invisible light. An anology of this might be a flame, fire-fly, cold light, etc. All forms of light seem to be due to a chemical action, which causes an enormous stress to be set up in the various substances, vibrating within the range of vision as light. But it seems that these visible and invisible rays of light as they strike the retina, are electrical waves, traveling with the speed of electricity, and not electro-magnetic waves as they are known at present.

In many different ways the Sun is identical with radium. It may be proved in the future even that the sun is radium, or a similar element. There are both visible and invisible rays sent out from the sun. Even the black spots on the sun may prove to be the brightest vibrating above visibility. Some day no doubt radium will be made cheap from well known elements by electricity, and will be a great factor for producing light and heat for future generations.

104—Photo-Properties of Light. As I have stated previously a chemical action will cause light; and light will cause a chemical action. When light strikes many chemicals it causes a change to take place probably by the electric-stress of light. This law is taken advantage of to reproduce pictures of objects and is better known as photography. The electro-static stress of light seems to cause a great change in the molecular form of elements. When we know more about the relation of electric waves, stress, molecules, adhesion and cohesion, we may know more about the internal molecular construction and behavior of elements.

CHAPTER 10.

MISCELLANEOUS IDEAS

105—Introduction. My study and experiments have not been directed to the wireless field alone, but in many other branches of science. So in this chapter I will review some of the things I have written and also branch off on other subjects. I want it plainly understood that I do not claim that any or all of my theories and ideas advanced in this book, are infallible. But as a student of science they seem to me to be far nearer right than the theories generally accepted today. I hope the reader can refer to the books to which I have referred throughout this book so that my theories and ideas will be better understood.

While negative electrons are undoubtedly the smallest known bodies to science, it seems to me that the actual atom of electricity, if such a thing is a fact, is far smaller than the negative electron.

106—Transmitter Buttons. It seems to me that the solid back type of transmitter is not the most simplified and efficient. The solid back type is partially rigid and cannot vibrate as freely as where the whole transmitter button vibrates with the diaphram. The Skinderviken button is an example of this. In a solid back type of transmitter, only one electrode vibrates, the other being stationary, whereas in a transmitter button, both electrodes vibrate in unison with the diaphram. In the latter the carbon granules are merely agitated and in the former they are compressed in unison with voice vibrations. When one electrode is placed on both sides of carbon chamber, and the whole vibrating with the diaphram in each forward

and backward movement of the diaphram, the carbon particles are compressed tighter against one electrode than the other, and vice versa. Thus when electrical resistance of the carbon increases against one electrode it decreases against the other, and it would seem that there could not be as great a variation of current, as where one electrode was disposed in a rigid manner.

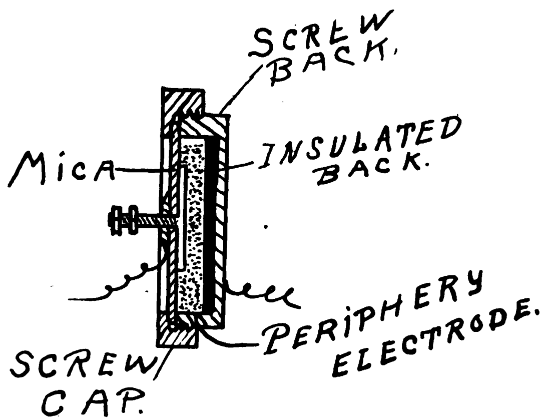


Fig. 65—Transmitter button having one electrode disposed on the periphery of the variable resistance chamber.

In order to make a greater variation of current with a given sound or magnetic wave, I propose that the transmitter button as shown in Fig. 65, where one electrode is on one side of the variable resistance chamber and the other electrode surrounds the periphery of same, thus when the diaphragm vibrates there is compression and decompression against the electrode on one side of the chamber of the carbon granules, the other side being insulated, a greater variation of the current should be the result.

In Fig. 66 is shown another modification of this type, wherein the carbon granules are placed inside of a chamber, having a plurality of insulated electrodes on one side of said chamber. The carbon granule

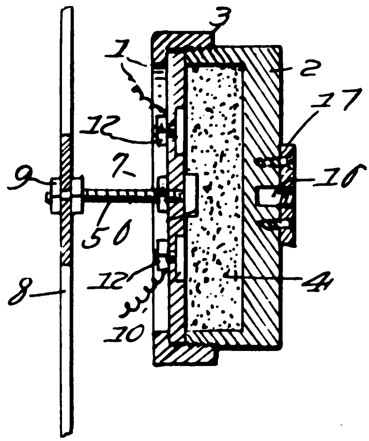


Fig. 66—Transmitter button having a plurality of electrodes on the side of the variable resistance chamber.

being compressed and decompressed against both electrodes simultaneously, thereby a large variation of the current is the result. These electrodes may be of any preferred form, such as concentric circles, of a smooth or projecting type.

A microphone or transmitter button, like an electro-static detector should have about the same resistance as the electro-magnetic device used in series. Thus if a 2000 ohm transmitter button is used in series with a battery and telephone receiver, the latter should also be 2000 ohms. A 75 ohm microphone should be used in series with a telephone receiver or primary of an induction coil having about 75 ohms resistance. For best results the secondary of an induction coil should have about the same electrical resistance as the telephone receiver used.

While carbon is far the best known element to use as electrodes and granulated conducting material in microphones at present, I have made some promising experiments with the use of bismuth, antimony, mercury, gold selenium and other elements.

In these types of transmitter buttons, a vacuum may be used, to prevent oxidization and sparking.

107—Thermo-Microphone. The thermo-microphone seems very interesting. One way to make a thermo-microphone is to use a thermo negative substance for one electrode and a thermo positive substance for the other electrode, and using for the granulated particles, either thermo-positive or negative substances. Another form is to use a thermo-couple in loose contact. One object of this type of microphone is to apply the Peltier effect to same. Sending a current in one direction will heat the microphone, sending it in the other direction will cool the microhopne. In sending the current in the direction that cools the microphone, the generated electricity is also added to the charging current. One trouble with microphone now is that they will heat rapidly under the influence of the primary current. But by using the thermo-microphone the microphone is cooled instead of heated. This type of microphone can also be used for a wireless telephone transmitter, the oscillating currents would tend to cool in one direction and heat in the other direction, thus it would not heat up like the microphones in use at the present. (See Art. 15.)

Another modification of this idea is that a microphone made of two dissimilar elements in some cases will talk without a battery, as the vibration of the diaphram will generate contact electricity. A microphone made of two electrodes composed of sodium and carbon is one example. The sodium being the positive, and carbon the negative element.

Thermo-microphones made up of the following substances seem to be very sensitive as transmitters and detectographs, the current should be sent from the positive to the negative element.

Electro-positive	Electro-negative
Galena	Selenium
Silicon	Tellurium
Iron pyrities	Carbon
Carborundum	Antimony
Bismuth	Silver
Nickel	Gold
Lead (Zero Metal)	Copper
Also many others	Iron
	Bronze
	Aluminum
	Cadmium
	Zinc
	Also many others

An analogy of the thermo-microphone is the crystal detector. It seems that some crystal detectors cool under the influence of oscillations when used with a local battery. This partly accounts for the amplification of a crystal detector.

108—Microphone Relay. There have been many different kinds of polarized microphonic relays used in the past. The electro-static tube seems to be a far better amplifier than any microphone relay in use at present, yet I do not believe that the microphonic relays have begun to reach mechanical and electrical perfection. In Fig. 67 I show one embodiment of an improved relay. This can be embodied in the form of a polarized or non-polarized relay. To use this as a polarized relay the permanent magnet 100 is removed, To use this device as a polarized receiver or relay, a local direct current can be used in the electro-magnet winding, a permanent magnet 100 may be used, or the casing 3 may be made of steel or nickel permanently magnetized. Also in the polarized or non-polarized type the diaphram may be resiliently tuned instead of magnetically tuned as shown in the drawing. One object in using this device in a non-polarized state is to

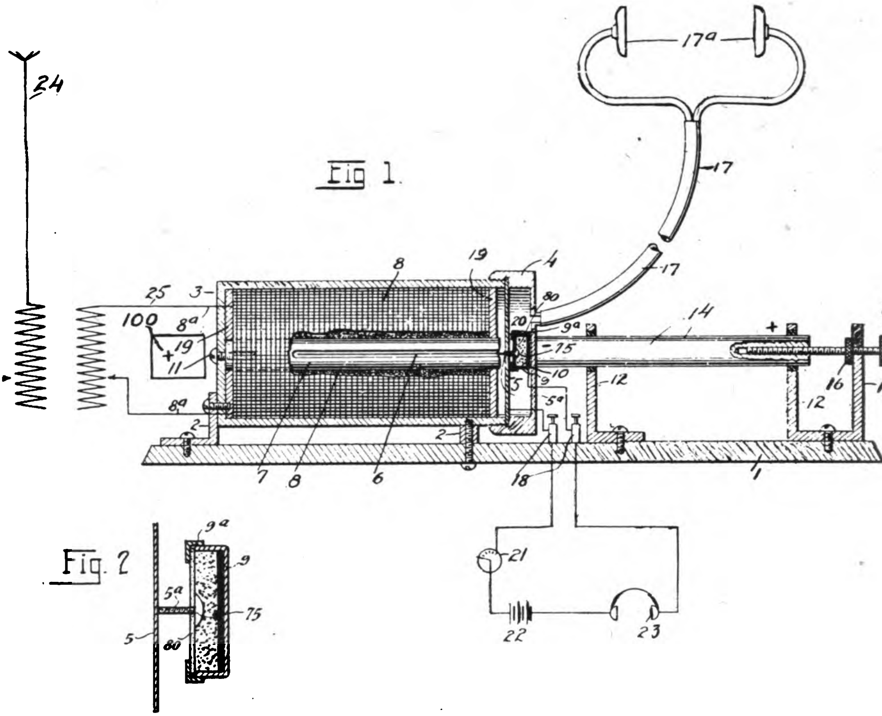


Fig. 67—Polarized or non-polarized relay.

receive wireless direct to a certain extent without a detector. Also for this work a non-conducting casing and core might give better results. In using for receiving wireless direct the electro-magnet should be wound to 10,000 ohms resistance or more. Either type will receive audio frequency wireless telephone or telegraph. If it is used as a receiver or relay in combination with a detector, then the electro-magnet should be wound to about the same resistance as the wireless detector. These relays may be connected in cascade

for further amplification. The microphone should have about the same electrical resistance as the telephone receivers used. If 2000 ohm telephone receivers are used then the microphone should have about the same resistance . If a 5 ohm telephone receiver is used then a microphone having about 5 ohms resistance should be used. There are many modifications of this device but I cannot mention them here.

If it is desired to use a thermo-microphone with this relay, the electrode 75 may be of bismuth as the positive element and the granulated particles and the back 9 may be of carbon. Although any other preferred thermo-couple may be used. The local current should be sent from the bismuth to carbon. Also the armature of the relay may be of soft iron, a permanent magnet, or soft iron, nickel or steel wound with a closed circuit. If a thermo-microphone is enclosed in a vacuum it will tend to prolong oxidization, and prevent sparking on heavy currents.

109—Electro-Static Receiver. There will no doubt be several ways to receive wireless in the future by electrostatic receivers, without a detector. In Fig. 68 I show probably one method of this kind of a re-

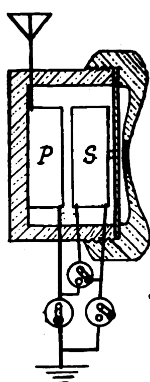


Fig. 68—Electro-static receiver.

ceiver, which includes a receiver case and cap, having a coil of insulated wire secured centrally, another coil is secured in a rigid manner to the casing. The former coil is free to vibrate with the diaphram. This type of receiver operates on the principle of the laws of electro or electro-static induction of two parallel circuits, which will cause either electro or electro-static attraction and repulsion. Currents travelling in the same direction in two parallel circuits attract one another and travelling in opposite directions repel each other. The rigid coil here I will call the primary and the coil mounted with the diaphram the secondary. When radio or audio frequency oscillations go through the primary coil, radio or audio-frequency currents are induced in the secondary coil. These currents are known as inverse and direct currents. It seems that the inverse currents are the strongest, hence the repulsion is greater than the attraction of these two coils. This mechanical movement is imparted to the diaphram and sound is sent out into the air, a group of radio oscillations giving one audible sound. These two coils may have a fixed or an adjustable wave length. When the two coils are tuned relative to one another the induced currents in the secondary coils are the strongest, so repulsion is greater. This receiver may be used with two coils in inductive relation to one another, or they may be connected serially together. Secondary coil is a closed circuit, having a natural wave length.

This type of receiver will probably work better on short wave lengths. as only a small amount of winding is then necessary for the coils. In long wave lengths it may be necessary to use additional tuning means. Also a conducting ring may be used for the secondary coil in some instances, and eddy current utilized.

In using for receiving radio oscillations direct, air, or a substance having a higher co-efficient of inductance

than air should be used as the core, and a non-conductive spring such as rubber be used to tune the diaphram to certain vibrations per second. The diaphram may also be tuned magnetically or by a metallic spring if the diaphram is tuned on opposite side of the coils. But if this device is used for electro-magnetic currents then a soft iron core will give better results. A permanent magnetic circuit may also be used through the coils. In receiving undamped waves local oscillating currents may be used in the secondary circuit.

In this type of receiver a complete wireless receiving system is the result, including a tuner, detector and telephone receiver. A close analogy of this device is the principle discovered by Elihu Thomson, described in Art. 533 in "Electricity and Magnetism" by Sylvanus P. Thompson. For instance a 200 meter receiver embodied in a double head telephone receiver, each coil would only need to be wound to 50 meters. Another analogy is the destruction of a double loop filament in an incandescent bulb, when lighted by currents of high pressure and frequencies.

If it is desired to use this device for purely electrostatic currents a non-conductive diaphram such as mica should be used as a conductor near the coils would tend to short circuit static attraction. But for electro-magnetic currents an armature of soft iron or nickel may be used, or even an armature being a permanent or electro-magnet.

110. Telephone and Telegraph Apparatus. In Fig. 69 is illustrated a complete telephone unit including a transmitter, telephone receiver, induction coil and signalling means, using only one electro-magnet. Sending the current in one direction seems to cause the device to howl, and sending in the other direction the device can be used as a telephone. One electro-magnet can be also used here as a combined telephone receiver and induction coil. This drawing is self explanatory,

a transmitter button 7 is connected to diaphram. A pole changing switch or key 18 is used in the primary circuit.

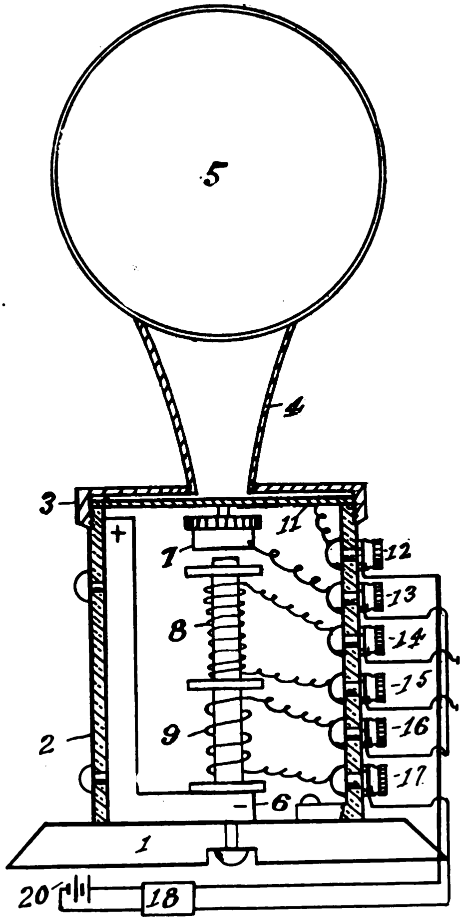


Fig. 69—Combined telephone and telegraph apparatus.

111—Signalling Apparatus. Various ways have been used to increase the sound from a diaphram. In Fig. 70 is illustrated one method. A hammer is held in a

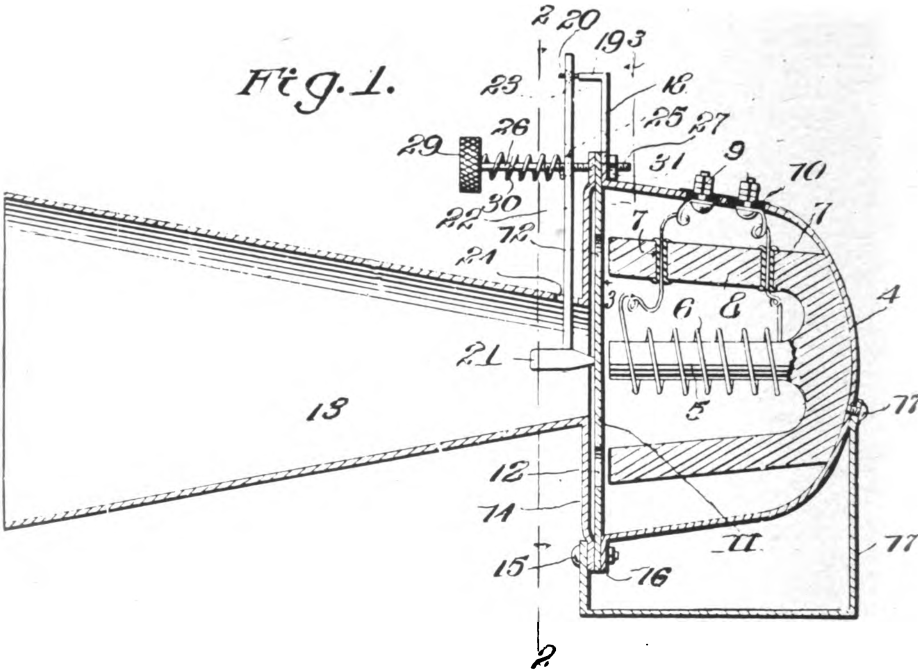


Fig. 70—Signalling apparatus.

resilient manner against the diaphram, when the diaphram vibrates the spring is tuned so that the hammer will be thrown away and against the diaphram, thus greatly increasing the sound emitted. This can be embodied as an auto horn, or for use on telephone receivers, for amplifying wireless messages.

112—Electrolytic Interrupters. The principle of operation of electrolytic interrupters has been claimed in the past, to be caused by gas bubbles being formed on the electrodes in the fluid, thus causing a corresponding change in resistance. This change occurs at about 5000 to 7000 times per second. It seems to me that this would be a mechanical impossibility. The operation of the interrupter seems to be caused by the electro-repulsion of a heavy current, carrying the fluid away from the platinum electrode in the direction of the current, thus breaking the circuit. As soon as this happens the natural pressure of the fluid and a current of electricity in the opposite direction brings the fluid back in electrical contact with said platinum electrode, then the same thing happens over again. Also the self induced inverse currents in the primary of the induction coil, help to bring the fluid back quicker, so no condenser need be used with an electrolytic interrupter, as the induced current of high potential assists in the operation of same. The electrolytic detector is a close analogy (See Art. 67.) It would seem to me that liquids or electrodes having a higher diamagnetic power, should cause more rapid pulsations. Also means to increase the pressure of the liquid should be an advantage. One way to do this would be to place the interrupter in a separate air tight container with a compressed air valve, so the pressure of the air on the liquid can be increased. Lead tubes could be disposed in an air tight manner through the container into the liquid, this could also be used for water circulation to cool the liquid and also for one electrode. I believe it is possible to get radio frequencies from an electrolytic interrupter for radio telephony. It also seems that an electrolytic interrupter can be made to work on much lower voltages than is necessary at present. It takes 60 volts to run an interrupter but 10 volts should do it. Experiments with bismuth electrode or a chemical using bismuth would be very interesting. Also other

chemicals of this nature. It seems in all forms and voltages of electricity, attraction and repulsion precede conduction. I believe this law can be applied to all voltages and frequencies of electricity. Conductors only provide a path for electric attraction and repulsion. Repulsion being from the positive electrode and attraction from the negative electrode. This law of attraction naturally carries a conducting fluid with it, thus the circuit in the interrupter is broken. If a vacuum is used in the container, the device should work on lower voltage.

113—Radio Telephone. The problem of radio telephony does not lie so much in the receiving apparatus as in the transmitting apparatus. As nearly all of the wireless detectors will receive wireless telephony as easy as telegraphy. More efficient and simple means are needed for the production of sustained oscillations having a frequency of 15000 per second or over. The most efficient means there are at present being the arc and vacuum tube method. In either case it is very expensve and not as simple as might be. I will only mention some ideas here as to producing sustained radio oscillations for transmitting wireless telephony. The vacuum tube is patented and the use of this is limited. It may be found that the gas tubes as described in Art. 77 will be efficient for this work, as well as the vapor tubes in Arts. 79 and 119. Spark gaps in different gases, vapor and liquids is also interesting. It also seems that the electrolytic interrupter can be made to produce radio oscillations. Either direct or through a single transformer, or also through a plurality of serially connected transformers. By a plurality of serially connected transformers I mean the secondary of each transformer connected to the primary of the next and so on. I applied early in 1915 for a patent on a system of sustained oscillations, using an interrupter for the primary of the

first transformer, and a plurality of transformers serially connected to the first. Thus each transformer multiplied the alterations by two. If there were 5000 alternations in the first transformer the second would be 10000 the third 20000 alternations and so on, in as many steps as desired. This should be practical for undamped wave telegraphy and radio-telephony. For audio frequency wireless telephony see Art. 47.

Static machines could also be used for sending audio-frequency or radio-frequency telephony.

Rarefied gas tubes seem to change their resistance under the influence of light and wireless waves.

The mercury arc can be also used for radio-telephony.

It seems that a system of radio-telephony whereby if heavy voice frequencies were used in the primary of a wireless transformer, and a train of oscillations generated for each voice frequency, would be an ideal system. One way this might be accomplished is to use an electrolytic interrupter with a voltage just below interruption, and then if heavy voice currents were impressed across the interrupter, it would cause the interrupter to operate at voice frequencies as well as the spark gap.

The arc circuit could also be used with an interrupter for voice frequency, damped or undamped waves.

Also the principle described in Art. 119 could cause heavy voice currents in the primary of a transformer, for radio-telephony. Of course the primary would have to be wound for about 100 volts, in order to use efficiently the altered currents of the vapor valve which takes about 100 volts to cause it to function.

114—Induction. The laws of magnetic, electro and electro-static induction are very interesting. We

know very little about it at present. But I have noted some phenomena that I believe will be of interest here. It seems that electro-magnetic and electro-static stress is the cause of induced currents, static electricity at rest and magnetism. There seems to be a field of stress about a permanent magnet and a static charge. As long as a neutral body is held in this field of stress opposite signs of electricity and magnetism appear (except opposite signs of magnetism do not appear in diamagnetic bodies), they then attract each other. But if the bodies had a like charge of magnetism or static then they would repel each other. The laws of magnetism and static seem to be very similar.

If a closed circuit of wire is passed through a field of stress of magnetism, an electric current is generated which flows in both directions. When the stress around the wire is increasing a current is flowing in one direction, when the stress around the wire is decreasing the current flows in the opposite direction. The same thing happens if a magnetic field is moved across a closed circuit of wire. The same thing also happens in the induction coil. Can we consider the induction coil an analogy of the crystal detector? If the primary current of an induction coil is of a constant strength, no current is induced in the secondary or primary. But if the stress is changing then currents are induced in the secondary and primary windings. Likewise when electro-static currents go through a crystal detector they induce or generate a local direct current having a much greater electro-motive force then the received oscillations, thus a crystal detector is a great amplifier. The crystal detector being of two different elements or substances, and having a natural polarity, currents are induced or generated in one direction only. Also the resistance of a detector seems to be changed under the action of electro-static stress. Several months ago I made a detector cup deeper by soldering a ring of tin around the top, thus making it about twice as deep as

it was. I secured a small crystal in metallic connection to the bottom of the cup, then I filled it full of sealing wax up to about the level of same, then with a buzzer I tested for the most sensitive spot. I kept the buzzer going and filled the cup full of sealing wax, having the receivers on my head so I could tell if the detector quit receiving. After several failures I succeeded in making a rigid detector, it could not be knocked out of adjustment by rough handling and kept its sensitiveness for months.

115—Antennae Currents. My study and experiments tend to show that the electro-static oscillaing currents in the antennae circuit are surprisingly small both for the sending and received currents. (See Art. 61.) The pressure of the arc stations in the antennae, is around 150,000 volts. I doubt if there are any of the high power stations in the world today that transmit one ampere to the antennae, at a pressure of 150,000 volts.

I believe it will be proven in the near future that the current transmitted to the antennae is several hundred times smaller than is generally supposed. Also that the strength of the received currents is several thousand times smaller than is generally supposed at present. The crystal and the electro-static tube detector amplify the received signals many hundreds of times their original strength in the antennae.

It seems that the self induced currents of a small buzzer operating on one cell, will generate oscillating currents with a potential sufficient to go through a vacuum.

It is claimed that a 500 K. W. arc station will radiate 275 amperes. What is the voltage? 275 amperes at 150.000 volts equals 41,250 K. W. The antennae voltage in high power stations is certainly

not less than 150.000 volts. An ampere at high frequency and pressure should have the same value as an ampere at a low frequency. If it does it would seem that if 275 amperes of current were radiated from an antennae, perpetual motion would be the result. But I don't believe above 500 K. W. station would radiate one ampere of current from the antennae, if a high frequency and pressure ampere is of the same value as one ampere for a low voltage direct current.

116—Interplanetary Wireless. Much has been in the press of late in regard to mysterious signals being received by some of the high power stations, some thinking they might be people on the planet Mars trying to signal us. I also have noted that a certain inventor is going to actually try to signal the people of Mars by wireless. Now I do not, nor would not try to discourage anybody in attempting scientific achievements, but as I understand wireless, unless the people of Mars had sensitive wireless detectors, thousands of times more sensitive than our 20 stage audion, the people of Mars could never hear our wireless. As I understand our wireless system that we have today, a circuit must be used. This circuit uses the natural media for same, and practically all of the current that leaves the antennae comes back to the earth again. Or in other words if any of the wireless currents reached Mars it would have to come back to the earth again.

A close analogy of this is submarine wireless. When the loop antennae of a submarine is just submerged it can send about 11 miles, with the top of the submarine submerged 8 feet the distance of transmission is only about one-fourth as much, due to the water short-circuiting more of the energy. In sending to Mars the rarefied air would act in a similar way to the water, as the rarefied air is a good conductor, but we must also remember that the rarefied air is very cold and is not as good a conductor as it would be if it was

of a temperature similar to sea level. I believe that beyond the rarefied air in space which is better known as the ether, there is a mighty small energy, if any, traverses it from our wireless stations.

Also if we would be able to hear wireless from Mars, the people there would doubtless have to use high power transmitting stations, having many thousand times the power we use in our largest stations. I cannot believe the mysterious signals received are from Mars, but probably from the Sun, static or experimental stations somewhere in the world using extra long wave lengths. It would only take about eight minutes for electricity to travel from the Sun to the Earth. No doubt but that a large part of the Earth and atmospheric electricity comes direct from the sun, in many different wave lengths.

It seems that the same amount of energy travels in a few vertical feet of the ground that travels in several vertical miles of air. The air and ground acting as two sides of a circuit equal energy must travel in both.

117 –Physiological Effects. It seems that there should be a closer co-operation of medical, chemical and electrical scientists, in the study and application of the effects of electricity upon the human body. The chemical and electrical reaction of all of the known forms of electricity should be closely studied. My theory is that all of the visible and invisible rays are waves of electricity. One of the effects of electric waves on a body is to generate electrical stress, and this stress generates as a secondary effect, heat, electricity, etc. The effects of stress on some of the deadly disease germs should be more thoroughly investigated. Experimenting with different rays or wave lengths is certainly interesting. Can disease germs be killed by electro-static stress? The Becquerel burn which is caused by exposure to radium or x-rays, is certainly

a secondary effect of electro-static stress. My experiments and study seem to show that life is far more dependent upon electricity, than is generally supposed. It also seems that the cause of all of our senses, is by electricity flowing through the nerves. It seems that the ear is an analogy of a crystal detector, as the sound waves strike the tympanum of the ear electricity is generated and transmitted to the brain by the auditory nerve. Seeing seems to be caused by visible electric waves going through the eye and transmitted unaltered to the brain by the optic nerve. Or a different form of electricity is generated by the cell of the eye and transmitted to the brain by the optic nerve. Tasting, feeling, and smelling seem to be due probably by certain forms of electricity generated by chemical, contact, pressure or thermo-electricity. There are many such ideas I could advance here but have not the space and time, but I trust that above will start someone thinking in this direction.

It would also seem to me that the pulmotor would be far more efficient in many cases if some artificial means were used to bring the body back to a normal temperature. Such as by heat from a fire, electrical means, etc. The body might be placed inside of a large coil of wire, heated by electricity, then the temperature could be more easily controlled. It would seem that some surprising results could be obtained, if the normal temperature of the body could be brought back in a reasonably short time. The action of artificial heat and the pulmotor could doubtless be used to an advantage in many cases before death, this might also save many lives. Of course in some cases artificial cold would be needed instead of heat, to keep the body at as near a normal temperature as possible.

Experiments should be carried out with the effects of all the different forms of electricity upon the

body. It should also be determined whether or not the high pressure high frequency current goes through or on the outer surface of the body, by conduction. It seems we can get no work out of electricity unless it is directed through a resistance or a strain caused thereby. If there is resistance or strain of the body in the passage of electricity, it causes pain or heat, or both.

118—Electricity in Schools. With the wholesale uses of the telephone, automobile, airplane, tractor, truck, wireless telephony and telegraphy, physiological and chemical effects of electricity, x-rays, electric light, etc., I believe the teaching of electricity will become a compulsory study in all schools. Electricity is being used more and more in every day life, a knowledge of electricity is now a necessity. It seems the more I study about electricity the more there is to learn, if all minds were trained on this subject, I would not dare to predict the future. All new discoveries seem to open up new fields of experimentation which doubtless are unlimited. When the truth is found in wireless, mysteries in other branches of electricity, gravitation, chemistry and magnetism will be solved.

119—Magnetic Control of a Flexible Gaseous or Vapor Conductor. The electron stream of vapor or gas can be magnetically repelled from a magnet. In Fig. 71 I show one method of altering the electron stream by magnetic repulsion. A tube having a cold or hot electrode capable of emitting electrons is disposed in the tube for one electrode, the other electrode consists of an extension of the core of an electro-magnet which is preferably of nickel or iron, the core acting for a part of the circuit of B battery is also the magnetic circuit, thus when the field is changing it alters the electron stream, which will act as an amplifier as heavy currents can be used in B battery circuit. The electro-magnet and core can be connected serially to alter the electron stream; in this case there is both electro and

magnetic repulsion of the vapor or gas conductor in the tube. In the embodiment shown a cold electrode of vapor is used, which will emit negative electrons.

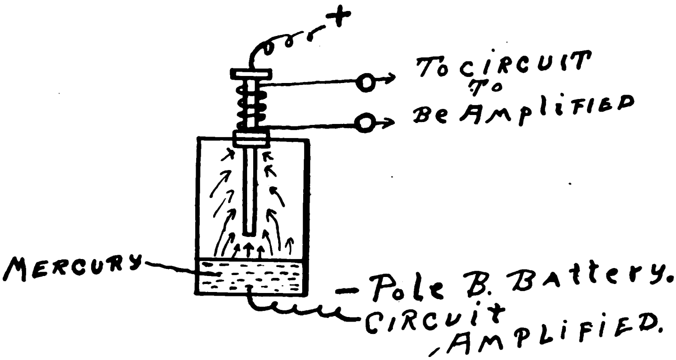


Fig. 71—Magnetic control of a flexible conductor.

120—High Tuned Receivers. The ear seems most sensitive to vibrations of from about 1000 to 2000 times per second. The telephone receiver as used now has a natural tune of about 400 times per second. If damped or undamped groups of oscillations were sent out about 1000 to 2000 times per second and a telephone receiver used to receive them having a like tune, smaller signals should be intensified and the interference of static reduced to a minimum. In Fig. 72 I show one method of raising the natural tune of a receiver by both permanent and electro-magnets to cause a stronger pull on the receiver diaphram. The resilient springs and the stiffness of the diaphram are adjusted to offset the magnetic pull this causes the diaphram to have a higher tune. It can be adjusted so that the diaphram will vibrate the easiest at about 1000 to 2000 times per second or even higher. If this type of receiver is used in combination with a microphone, then the device can be used as a howler, at the rate of 2000 per second or over.

It should be practical to use a Goldschmidt tone wheel in series with the antennae when transmitting undamped waves, as any method that will cut up the undamped waves at the receiving end, will also cut up static. I believe this method would cause a greater variation in the strength of the groups of oscillations received. Then too no oscillating detector would be needed at the receiving end. This should greatly eliminate static.

The armature 11 may also be embodied in the form of a permanent magnet. Also a soft iron or a perman-

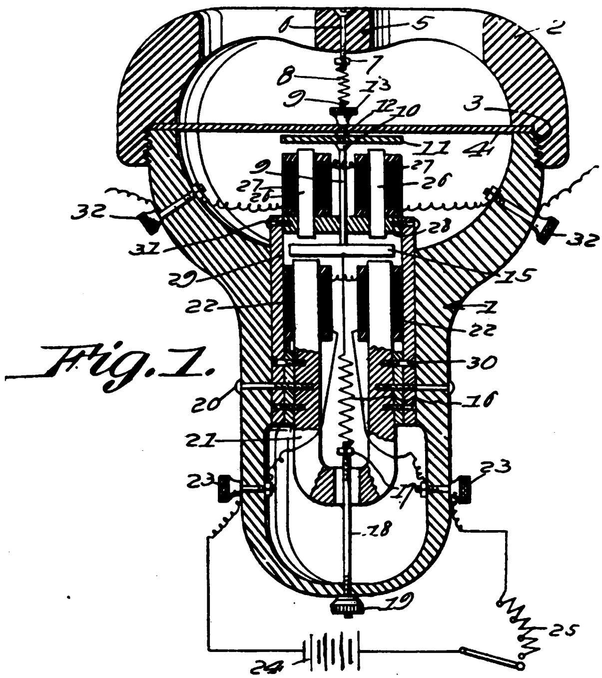


Fig. 72—High tone receiver.

ent magnet wound with a closed electric circuit, to inductively aid in polarization.

121—Telephone Receivers and Detectors. It is a law in wireless detectors, that they should have the same D. C. resistance as the telephone receivers used. This law alone should prove that crystal detectors are not valves or rectifiers. Why not extend this law and use detectors of ten, fifty and one hundred thousand ohms or over, and use telephone receivers or primary of audio-frequency transformers having the same resistance. If the latter were used the secondary winding could have 2000 ohms resistance and a telephone receiver having a like resistance. Or a plurality of detectors could be serially connected to raise the resistance, but the electro-magnetic receiving device should have the same resistance for the best results. In connecting crystal detectors serially, sealed or rigid detectors should be of value.

122—Rectifiers. There are several devices that have the property of allowing certain forms of electric currents to travel in one direction, far better than in the other. Among them are the electrolytic, vapor and vacuum valve. It seems that a law in electricity is that the current always travels from the consumed to the non-consumed element. In a voltaic cell this seems to be from the anode to the kathode in the electrolyte. In the electro-plating fluid the direction seems to be from the anode to the kathode. In the electrolytic interrupter the direction of the current seems to be from the anode to the kathode. But in the case of the direction of flow in the vapor rectifier, the current flows from the (negative) mercury to the iron (positive) electrode. It seems that on the iron plate the unlike electricities unite. In this case the mercury is a continuation of the negative pole and the iron a continuation of the positive pole. It seems that the copper or positive pole attracts the negative

electricity, both through the vapor and electrolyte. If the current is from the mercury to the iron electrode, small electrons of vapor carry the current, but if the current is in the other direction, the electrons are repelled from the iron and the circuit is broken. Thus this acts as a valve. The vacuum valve works in like manner. When the direction of the currents is from the filament to the positive plate electrons flow, but when the current is in the other direction, the current is shut off because there are few electrons to be carried from the plate to the filament. It seems that there are no positive electrons, because the electrons are always repelled from the negative pole, and attracted or drawn to the positive pole. But I believe high pressure high frequency current of small amperage will travel in both directions through the valves. When the vacuum tube generates radio oscillations both directions of the generated currents certainly go through the tube. (See Fig. 73.)

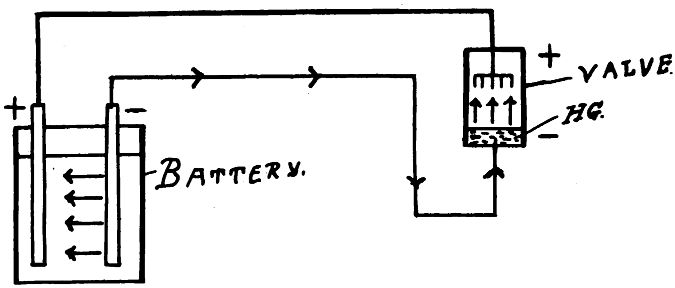


Fig. 73—Illustrating how the undercharged copper plate attracts negative electrons, or that the zinc plate repels negative electrons in the same direction through the battery valve.

A condenser works on the principle of electric attraction and repulsion when discharged and causes it to oscillate. The positive electricity attracting the negative, as soon as this happens the positive plate is over-

charged, the polarity changed and then there is attraction in the opposite direction. This changing of polarity occurs many times in the discharge of a condenser, the frequency depending on the resistance of the circuit and capacity of the condenser.

123—Electric Penetration. The study of electric penetration is very interesting. In low voltage direct, and low frequency alternating currents the electricity seems to penetrate clear into the center of the wire or conductor. In currents at high frequencies and pressure the electricity seems to penetrate only into a small percentage of the conductor, thus a hollow copper rod does not offer any more resistance to same than a solid rod of like material. It also seems that the penetration decreases with the increase of the frequencies. Thus when wireless currents travel through the ground by conduction the long wave lengths penetrate deeper than the short wave lengths due probably, owing to the lower frequency of the former.

When currents at high pressure and frequency travel by conduction, conductors at a low voltage, the current seems to travel near the surface thereof, and does not seem to penetrate into the molecules of the center, but when high frequency high pressure currents go through by conduction insulators at a low voltage, the current seems to charge or penetrate into every atom, thus the air all becomes charged when wireless currents are passing through. Fresh water being a poorer conductor than the earth, wireless currents will penetrate deeper into the water than they will in the ground. It also seems that when high frequency high pressure currents go through a wire, the current being of a static nature and flowing in the same direction, like electricities are naturally repelled to the outside of the surface. An analogy of this is electro-static electricity at rest.

From this law some light might be obtained as to how deep currents at high pressures and frequencies pentrate the human body, by comparing the conductivity of the body to other known conductors.

It seems that the electric waves, or rays of daylight and the alpha rays of radium are very similar, probably positive waves of electricity, and have small penetrating power. A sheet of paper will stop them. The kathode rays of the Crooks tube and the beta rays of radium seem to be very similar, being probably negative waves of electricity, and have great penetration, will penetrate with ease sheets of glass, aluminum, etc., several millimeters thick. The X-rays and the gamma rays of radium seem very similar, have extra high penetrating power and seem to be oscillations of negative and positive electricity, traveling with the speed of light and electricity. The latter rays will penetrate a sheet of lead 7 centimeters thick. The latter may also be negative waves of electricity of an unusual high frequency. (See Art. 100.)

When we know for certain more laws regarding the penetration of various elements by all the known forms of electricity, we can learn more about the molecular and inner construction of elements.

It also seems that the frequency of electric waves whether of a high or low voltage, determines to a great extent the conductive power of electricity. Electric waves having a high frequency will go through a far greater resistance than the same voltage at a lower frequency. Thus at frequencies of wireless the air becomes a good conductor, at the frequencies of light, a cold vacuum is a good conductor, and at frequencies and nature of X-rays, electricity will penetrate various bodies.

In applying the theory of attraction and repulsion of electricity, being conduction, to the Solar system,

electricity would be repelled from the Sun and attracted by the ether or space of the universe in heat and light frequencies. Also according to this theory static attraction and repulsion would reach across the millions of miles of space from the Sun to the planets.

The electrical storms of the western plains are a strange phenomena. There is no lightning or thunder, but electricity is attracted seemingly from the earth up to the rarefied air above. The amount of the transfer of electricity in this manner is surprising, every plant, tree or object extending up in the air aids in the discharge of electricity, by the high density of points. The dust particles seem to provide an easier path for this attraction. But dust is certainly not the only cause, as there are hundreds of dust storms with no visible display of electricity. It seems that the state of the rarefied air is the main cause for this phenomena. During an electrical storm of this nature a person will get severe shocks when touching fairly insulated con-conducting objects. I have seen the brush discharge stream from the points of barb wire fences, from a stick held in the hand, from the horns of cattle, and from vegetation. Another peculiar effect of such a storm is that all green plant life is killed. It would seem that the electro-static stress set up in the molecules of plant life, in some manner caused them to die. This seems another result of severe electro-static stress set up in objects. See Art. 12. The effect of this electricity on plant life is very similar to a heavy frost.

124—Wire Wireless. When the radio oscillations are directed through a metallic circuit instead of using the natural media, it is known as wire wireless. Early in 1916 I filed application for a patent on wire wireless, not knowing then it had already been patented. It seems to me that wire wireless proves that there must be a circuit for wireless transmission, regardless of the media used. By the use of wire wireless a num-

ber of telephonic messages can be carried on the same circuit simultaneously, without interfering with each other in the least. This also applies to wireless telegraphy on a wire circuit.

125—Loop Antennae. If a loop of wire having the natural tune o: the messages intended to receive, electric attraction will act through the coil to the ground, provided the coil is parallel to lines of attraction or conduction. The energy received in the loop antennae is thousands of times smaller than is generally believed at present, attraction and repulsion of electricity being stronger from the direction of the transmitting station. This constitutes a wireless compass. As electricity will seek the earth the strongest on the side of the coil that is next to the transmitting station, if this side be connected to the grid. If the loop is grounded, the signals are increased because the grounded wire offers less resistance to electric attraction and repulsion to act between the air and ground, thus more current will travel through the detector. In this article and also others I have referred to the conduction of electricity being due to electric attraction and repulsion. An analogy of this law is that iron is a better conductor of magnetic attraction than air. So copper is a better conductor for electric attraction than air. But there is a great difference between magnetic and electric attraction and repulsion. It is supposed at present that induction is the cause of the oscillations in the loop antennae, but this seems to me against the laws of electricity. (See Art. 60.)

It seems to me that the loop antennae as now used on submarines, invented by Dr. Rogers is a re-discovery of the loop antennae as used by S. F. B. Morse in 1842. (See Art. 22.) The only difference being in the form of electricity used, and the grounded wire being insulated.

126—Electro and Magnetic Attraction. In the flow of electricity from one place to another is there anything transmitted? There does not seem to be. Gravitation, magnetism and electricity seem to be all identical in this sense—that all three of these phenomena are an attractive force acting across a distance. The attraction of gravitation goes through all known substances. The attraction of magnetism goes through some substances easier than others, such as iron, nickel, cobalt, etc. Also magnetism goes easier through air than copper, zinc, lead, silver, carbon, gold, mercury, antimony, bismuth, etc. The attraction of electricity goes through certain substances easier than others. The attraction of electricity is divided in three classes, namely low voltage direct currents, static currents and high frequency currents (which includes wireless, light and X-ray frequencies).

The attraction of low voltage electricity will go easy through substances like silver, copper, iron, zinc, electrolyte, etc. But not through air, glass, rubber, guta-percha, mica, etc.

The attraction of static electricity will go easy through practically all known substances, but easier through some than others.

The attraction of high frequency electricity will go through all known substances with ease.

Nothing seems to offer any resistance to the attraction of gravitation.

Magnetism will act through all known substances.

When electric attraction has to pass through resistance, heat and magnetism is a secondary effect, the lines of electric attraction always being at right angles to lines of magnetic attraction, and vica versa.

When we speak of electricity flowing through a conductor, we generally call it an electric current. But I believe this is a current of force of attraction rather than the probable transfer of matter.

In convection currents however, small electrons are attracted from the negative by the positive pole. This is doubtless the smallest known forms of matter. These electrons which are attracted act as carriers for negative electricity producing an electric current. This seemingly transfer of matter only goes from the anode to the cathode. There seems to be no positive electrons because the negative pole would not attract them. Electric attraction being in one direction only.

By this theory light should be short waves of electric force (or attraction) through the natural media.

It has never been possible to separate positive and negative electricity in low voltage currents, as it has static electricity. In static electricity one body will hold either a charge of negative or positive electricity. By separating the unlike signs of electricity and noting their behavior it should help us to further understand this little understood phenomena. If bodies charged with like electricity are brought close together, repulsion is the result. If bodies with unlike electricity be brought close together attraction is the result. This seems to prove that the flow of electricity is caused by attraction. If the like poles of a battery are connected together there is no flow of currents, but if unlike poles be connected then there is a flow of current.

In this respect the law of electricity and magnetism are the same. Like poles of electricity and magnetism repel and unlike poles of magnetism and electricity attract. When like poles are disposed together there is no magnetic or electric circuit but when unlike poles are disposed together there are both magnetic and electric circuits.

There can be no magnetism without a circuit, neither can there be electricity without a circuit, except probably electricity in frequencies of heat, light and X-rays, (yet there may be a circuit even in the latter phenomena).

The relation of gravitation, magnetism and electricity is a promising and interesting study. There is such a broad field in these phenomena to be yet explored. If we only knew the secrets in store for us in this direction, how simple they would be—but now many of these secrets look like inaccessible mountains.

The distance at which induction or attraction of electricity or magnetism will take place, depends upon the conductivity of the intervening medium. In electricity this also depends upon the voltage and frequency of the charge or current. For instance in static electricity at rest, if a charged body be disposed in attractive or inductive relation to a neutral body, opposite signs of electricity will be attracted on the neutral body next to the charged body, and unlike charge on the opposite side of the neutral body. This electric attraction across the natural or intervening medium is governed to a great extent by the conductivity of the medium, the distance at which electric attraction will act increases with the conductivity of the intervening medium. This electric attraction is also known at present as electro-static induction. For instance electro attraction will act much farther through a Geissler tube than through air at atmospheric pressure, because it is a much better conductor.

All bodies seem to be charged with electricity, but before we can get electricity from a body we must unbalance the positive and negative electricity by attraction or repulsion. This can be done by friction, chemical action, magnetic means, etc.

From the reading of this article the reader will naturally think that the phenomena we call electrostatic induction would act farther across a conductor than the real conduction of electricity, but I believe electro-static induction is pure conduction, which I

believe the future will prove. For instance these lines of electro-static induction can be short-circuited by any good conductor for low voltages. Conduction of electricity seem to be attraction or induction acting through a conductor. This unseen force may be in steady, pulsating or oscillating waves.

The laws governing magnetic induction and electro-static induction are vastly different.

It seems that the transmission of wireless is by pure conduction currents, and the transmission of light in the nature of displacement currents. By displacement currents I mean the attractive force of electricity acting through the intervening or natural media.

127—Soaring Flight. Much has been written regarding the phenomena of soaring flight. While this subject seems a great departure from electricity, I have studied in this field also, and I believe it will be interesting to the reader. Soaring flight is regarded by many to be the goal of efficient flying. A soaring bird requires power to raise at an altitude for soaring but after once reached it seems that a soaring bird can stay in the air all day without the expenditure of any power. There are several soaring movements. The main one seems to be that of going against the wind and with it. When a bird has gained quite a momentum it turns quickly against the wind, the wings at a high angle of incidence, the result is that the bird is quickly raised to a much higher level. The bird then turns with the wind with the rear of its wings raised a little, the wind acts to both carry the bird forward and to also raise it, but when the momentum of the bird is near to the speed of the wind the bird then gradually falls a little. Then the bird turns quickly against the wind with the front edges of the wing raised, the result is that the bird is again raised to a higher level and the same operation is repeated over and over without even a single flap of its wings. Thus the bird seems to fly

in elliptical circles with its wings spread out in a rigid manner, gradually going with the wind. Soaring is also possible to a great extent in still air, as the momentum of a fast flying bird will raise it to a greater height, when it suddenly raises the angle of the incidence of its wings to the line of flight. When a soaring bird goes against the wind the angle of incidence of its wings is raised to the line of flight, when the bird goes with the wind the angle of incidence is reversed so that the wind will urge the bird forward and upward. Some birds seems to have feathers that drop down from the under front edge of their wings, which act as valves, opening when going with the wind and closing when going against it, this also greatly helps in the soaring movement.

128—Manual Flight. For centuries past man has tried to fly by manual power. Practically all the aeronautical engineers today declare it is impossible, and would laugh at the idea of manual flight. But I have experimented enough that I am convinced it is possible. Not only is manual flight possible but a practical ornithopter is possible driven by a small motor for carrying one passenger. Under favorable conditions with the wind I have flown about 100 feet using a pair of manually operated wings, having only 15 square feet of angular plane surface. In still air I have taken long jumps with a poorly made model. I also have jumped from elevated structures and alighted on the ground in safety. Although when I made my longest flight with the wind I did not alight very safe, or easy, as I must have been going about 25 miles per hour.

I have experimented with several types of wings. Among the first type I used was a light frame having 3 wing bars on each side rigidly secured to the main frame for vertical movement only. To these wings bars were secured in a rigid manner an angulary sur-

face of light cloth having a light paper glued thereto to make air tight, the angular surface was disposed so that on the downward movement of the wings it would tend to raise the machine upward and forward. These wing bars were about 65 inches long. And on the top ends for about 48 inches was the angular disposed covering which was about 10 inches wide. Each one of these I will call a large feather. Each wing had three of these feathers secured to a frame which hinged to the main frame for vertical movement. The main frame being strapped under the arm pits and to the body. The wings were counter balanced by resilient springs which not only balanced them against their weight and the wind, but also assisted in more rapid vibration. A cross bar acting as a part of the frame about 18 inches from the hinge end was used as the hand hold to vibrate the wings. This type of wings is efficient for going with the wind, but is not efficient in still air, or against the wind.

In order to make this type of wing or feather efficient in still air and for going against the wind, I invented wings or feathers using rigid feathers disposed so as on the downward movement of wings they would tend to urge the machine upward and forward, but on the upward movement of the wings they were made to feather rear-wardly by the resistance of the air and resilient means, in a manner similar to the wings of a bird in flapping flight. When the angular disposed feathers are feathered rear-wardly on the upward movement of the wings, they offer practically no resistance. The wing bars or feathers hinged rearwardly at about 18 inches from the vertical hinge end. In this type of wings the wings or feathers fold rearwardly on the up-stroke offering practically no resistance, but on the down stroke the wings or feathers spread out-wardly by resilient means also by air pressure, thus the wings offer a great resistance on the down

stroke. In this type of ornithopter we have as the dominating factors, the resistance of the air, the resistance of a bouyant body through the air and inertia, or the momentum of a body in motion. The easiest way to start with either of these machines is to run with the wind, down an inclined plane or from an elevated structure. Momentum is an absolute necessity in a machine of this type, when used by manual power. This type of machine is the nearest imitation of the movement of the wings of a bird I have ever read. This will be one of the leading sports in the near future. The model I used only weighed about 8 pounds, was made of paper, cloth and white pine. To get the greatest efficiency from this type of machine the feathers should be curved longitudinally and fore and aft, so as to prevent the rapid escape of the air when under pressure. The feathers I used were disposed at an angle of about 30 degrees. Small ornithopters of the type herein described can be made to carry a person using only a small motor, by the careful proportioning of the various parts. The laws of dynamics of the air, will bring into use many types of flying machines. airplanes, dirigibles, combined airplane and dirigible, helicopters, propellers mounted in concentric for opposite rotation, vacuum flying machine, ornithopters and soaring machines.

129—Conclusion. I regret that I have not had more time and space to make some of my points more clear, but I hope to have in the near future far more interesting matter than there is in this book. I want to make it plain that I do not claim any or all the theories, discoveries and ideas advanced in this book are infallible. Many mistakes will be made until the truth is found. But after years of careful study and experimenting with the limited means at my command, most of the new theories advanced herein seem to me to be a far better explanation for certain phenomena

than those that are being used at present. I believe also that the future will bear me out in this claim. All the late inventions seem to prove my theories. I have patents pending on many of the new ideas advanced in this book, also on ideas not published herein.

I believe that if those that have a chemical and electrical laboratory and means at their command, will experiment with my theories in mind some surprising results will quickly follow. Also by the continuation of my theories and discoveries we will know, in the near future more about some of the mysteries of electricity, gravitation, physics, magnetism and chemistry.

My study and experimenting has just begun, will reach out farther as my means permit. It seems that we are on the brink of some great discoveries in science that will revolutionize present methods and appliances. We know mighty little yet about electricity, magnetism and chemistry. There are thousands of mysterious phenomena yet to be discovered, it is only a matter of time until this will be accomplished.

The arguments that I have advanced here as revolutionary theories in science, are not based on the experiments and ideas herein published alone, but on experiments, discoveries and ideas published and unpublished. This book is only a small part of the result of my study and research in science. To apply the laws of unknown forces to the welfare of Humanity we must study, experiment and work—Never tire, and and laugh at failures.

Some of the mysteries of electrical and magnetic stress of substances will doubtless be discovered, we too should learn more of the molecular construction and behavior of elements and combination of same. One aim of this book is to open up new fields of experimentation to which there will be no end, and laying the foundation for far greater discoveries, and stimu-

lating experimental and research work and study on a far larger scale than ever before attempted, that more of the wonderful works of God may be understood.

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